Docket Nos. F-2019-3008809 and F-2019-3008832

COMPLAINANTS' MOTION IN OPPOSITION
to
Respondent PPL Electric Utilities' Motion in Limine
to
Exclude Complainants' Evidentiary Exhibits

Complainants' Motion in Opposition pertains specifically to those exhibits which were identified and listed individually in the Complainants' Amended Complaint.

In their Amended Complaint, the Complainants have asserted, and we fervently, judiciously, and with objective certitude, shall assert again what should be painfully obvious:

> "No rational, impartial, unbiased person of sound reason who views the demonstrations and thoroughly reads and adequately understands the overall compelling scientific evidence, scientists' testimonies and pertinent information brought forth in this complaint would conclude or could honestly claim in earnest that chronic, continual, day-and-night, long-term exposure to radiofrequency radiation and electromagnetic fields produced by wireless smart meters is safe and without hazard or substantive risk of adverse effect upon public health and safety and that such exposure cannot, could not, does not, and will not cause harm to the people and citizens of this state."

Complainants hereby set forth the grounds for their opposition to Respondent's Motion in Limine in order that the Complainants' due process right to present relevant, credible and reliable evidence of definite probative value in the forms of various exhibits is fully and properly preserved and entered into the evidentiary record of this case following upon careful examination and thorough scrutiny by this Court of Administrative Law.

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I. Prima Facie Established and Indisputable FACTS

1) On May 31, 2011, the *IARC/WHO* issued *Press Release No. 208* which stated:

> "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, associated with wireless phone use. ... 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.'" (Underlining and emphasis added.)

2) In November, 2018, The U.S. National Toxicology Program (NTP) of National Institutes of Health (NIH) and National Institute of Environmental Health Sciences (NIEHS) published its highly peer-reviewed, final report with findings of **"clear evidence"** of cancer causation in animal test subjects resulting from exposures to modulated radiofrequency radiation of 900 MHz.

3) In 2018, researchers at the world-renowned Ramazzini Institute also reported findings of malignant tumors in animal test subjects resulting from exposures to radiofrequency radiation at much lower SAR levels than the NTP levels of exposure.

4) To *forcibly* subject persons to chronic, long-term exposure to a definitely possible human carcinogen is to *forcibly* subject them to chronic, long-term exposure very possibly to a definite human carcinogen.

II. Verifiable and Provable FACTS

1) According to Dr. Robert A. Baan of IARC, "[I]nformation from studies with experimental animals showed that effects on cancer incidence and cancer latency were seen with exposures to different frequencies within the RF region. So **the classification 2B, possibly carcinogenic, holds for all types of radiation within the radiofrequency part of the electromagnetic spectrum**, **including the radiation emitted by** base-station antennas, radio/TV towers, radar, Wi-Fi, **smart meters**, etc." (Underlining and emphasis added.)

2) The FCC/ANSI/IEEE safety standards are based on a thermal effect radiofrequency radiation and are protective of effects arising from a thermal mechanism, but not from all possible mechanisms. Therefore, the generalization that 1992 ANSI/IEEE guidelines protect human beings from harm by any mechanism is not justified.

3) According to the *Handbook of Biological Effects of Electromagnetic Fields, Third Edition: Biological and Medical Aspects of Electromagnetic Fields*, published in 2007, the clinical evidence for weak (nonthermal) EMF bioeffects, derived from many double-blind clinical studies, has become overwhelming.

4) There are many hundreds of peer-reviewed scientific studies with positive findings of biological and/or adverse health effects of RF exposures below the standards adopted by the FCC that apply to thermal heating effects.

5) There are numerous peer-reviewed scientific studies with positive findings of biological and/or adverse health effects of extremely low levels of RF exposures that are far below the FCC guidelines that apply to thermal heating effects.

6) There are no empirical scientific studies of AMI wireless smart meters specifically with respect to biological or adverse health effects of exposures to the pulsed transmissions and modulations of radiofrequency radiation and RF fields produced by these devices.

7) There are no objective scientific studies that have established any conclusive evidence whatsoever that chronic, frequent, day-and-night, long-term exposure to radiofrequency radiation and/or RF fields, even at extremely low levels, is safe.

8) There are no objective scientific studies that have established any conclusive evidence whatsoever that chronic, frequent, day-and-night, long-term exposure to radiofrequency radiation and/or RF fields, at levels produced by AMI wireless smart meters, is safe.

9) According to the testimony of Sheldon Meyers, Director of the Office of Radiation Programs of the U.S. Environmental Protection Agency, given on October 6, 1987 at a subcommittee hearing of the U.S. House of Representatives: "empirically, **it is not possible to assign a low intensity**

limit or threshold below which the exposures are without effect." ... "The research information now available, both from EPA and others, demonstrates that biological systems do respond when exposed to ELF fields." (Underlining and emphasis added.)

III. Evidentiary Standards and Criteria

Evidence is relevant if it tends to establish facts in issue. *LeRoi v. Pa. State Civil Service Commission,* 382 A.2d 1260 (Pa. Cmwlth. 1978).

"Commonwealth agencies shall not be bound by technical rules of evidence at agency hearings, and **all relevant evidence of reasonably probative value may be received**." 2 Pa. C.S. § 505.

The Pennsylvania Public Utility Commission, a Commonwealth agency, is not bound by technical rules of evidence at agency hearings and therefore may receive all relevant evidence of reasonably probative value.

If the evidence is relevant to the issues before the agency and of reasonable probative value, the agency may receive it. 2 Pa. C.S. § 505.

Hearsay evidence may generally be received and considered during an administrative proceeding. *See A.Y. v. Commonwealth, Dep't of Pub. Welfare, Allegheny County Children & Youth Serv.,* 537 Pa. 116, 641 A.2d 1148, 1150 (1994).

Under the relaxed evidentiary standards applicable to administrative proceedings, as provided under 2 Pa. C.S. § 505, it is well-settled that simple hearsay evidence, which otherwise would be inadmissible at a trial, **generally may be received into evidence and considered during an administrative proceeding.** *D'Alessandro v. Pennsylvania State Police,* 937 A.2d 404, 411, 594 Pa. 500, 512 (2007).

Substantial evidence is such relevant evidence as a reasonable mind might accept as adequate to support a conclusion. *Borough of E. McKeesport v. Special/Temporary Civil Serv. Comm'n*, 942 A.2d 274, 281 n.9 (Pa. Cmwlth. 2008)

Substantial evidence must be "more than a scintilla and must do more than create a suspicion of the existence of the fact to be established." *Kyu Son Yi v. State Bd. of Veterinary Med.*, 960 A.2d 864, 874 (Pa. Cmwlth. 2008).

In order for evidence relied upon in an administrative proceeding to be considered "substantial evidence," the ". . . information admitted into evidence must have sufficient indicia of reliability . . . " *Gibson v. W.C.A.B,* 861 A.2d 938, 944, 580 Pa. 470, 480 (Pa. 2004).

To satisfy the requirement of authenticating or identifying an item of evidence ... "the proponent must produce evidence sufficient to support a finding that the item is what the proponent claims it is." Pa. R.E., Rule 901.

Evidence which is corroborated by any competent evidence in the record must be given its "natural probative" effect.

IV. Evidence

A. Health and Safety: Biological Hazards and Risks of Exposure to Radiofrequency Radiation and RF Fields

1. Evidence by Demonstration and Direct Observation: Exhibits with Content Which Is Directly Observable, Demonstrable, and/or Verifiable in Principle, in Real Time

1) Demonstrations of Immediate and Directly Observable Effects of the Operation of RF Radiation-and-Field-Producing Devices Including PPL's Landis+Gyr Focus AXR AMI Meters.

2) Characteristics of the Landis+Gyr AMI Meter.

This section includes the following:

Exhibit Nos. 2, 3, 5, 31A, 31B-1, 31B-2, 31B-3, 31C, 38A, 38B, 38C, 38D, 38E, 46L-2, 46L-3, 46L-4, and 46L-5.

All of the exhibits listed within this section, especially those which involve demonstration and direct observation, constitute directly relevant and credible evidence of reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

Both **EXHIBIT 2** and **EXHIBIT 3** clearly show, by means of demonstration, that the operations of radiofrequency-propagating smart meter and Wi-Fi devices can and do cause ***immediate***, ***directly observable*** effects upon human cardiologic function:

EXHIBIT 2 (FD):
Demonstration of direct, disruptive effect upon human heart function by operation of a wireless smart meter. The device used in the demonstration is a **'Landis+Gyr Focus AXR'** AMI smart meter—***the same make and model as those deployed by PPL Electric Utilities***.

EXHIBIT 3 (FD):
Demonstration of direct and immediate, disruptive effect upon human heart function by Wi-Fi device generating radiofrequency emissions at power density levels ***well below government safety guidelines***. (Note: The safety guidelines referred to in the demonstration are part of Canada's *Safety Code 6* and are practically identical to the guidelines adopted by the FCC.) The demonstration is followed by brief commentary by the demonstrator, a PhD, and three medical doctors, including Dr. David Carpenter, MD, Director of the Institute for Health and Environment, University at Albany School of Public Health, State University of New York.

Assuming the integrity, veracity and technical competence of the persons in these demonstrations, the demonstrations in **EXHIBITS 2 and 3** constitute visual, **objective evidence of direct causation** which ***cannot be disproven or explained away merely by resorting to oral or written testimony*** *from any number of for-hire expert witnesses*.

EXHIBIT 5 (FD):
Demonstration of generation and propagation of conducted emissions of high-frequency voltage transients, or harmonics, specifically by the operation of an AMI wireless smart meter. A number of these radiofrequencies in the kHz range are known and used in experimental research to cause 'nerve conduction block' in animal test subjects, as per **EXHIBITS 6A through 6F**.

These same radiofrequencies generated by wireless smart meters as high-frequency voltage transients of conducted emissions propagate through the electrical circuits of a home or building structure, generating EMFs that extend outward from the walls and into the living and working spaces throughout the home or building, thus effectively turning the electrical wiring and circuitry of the entire structure into a secondary radiofrequency antenna.

The device used in the **EXHIBIT 5** demonstration is a '**Landis+Gyr Focus AXR**' smart meter—***the same make and model as those deployed by PPL Electric Utilities***. The conducted emissions of high-frequency voltage transients produced by the Landis+Gyr wireless smart meter in the demonstration are visually compared with those of the standard analog meter installed on the structure. The distortion of the standard 60-Hz waveform by the high-frequency voltage transients produced by the smart meter is clearly seen on an oscilloscope to be in stark contrast to the waveform which remained free of distortion when incoming current was passing through the analog meter.

EXHIBIT 31A (FD):
Dark-field microscopy visualization of blood samples taken from test subjects before and after 2-minute exposures to an analog electric meter at a distance of 1 foot as compared with samples taken from the same subjects before and after exposures to a smart meter under otherwise the same conditions. Each of the subjects' blood cells appeared to be normal before and after exposure to the analog meter and also before exposure to the smart meter. However, after exposure to the smart meter, the blood cells of each of the subjects visibly showed marked structural degradation and damage. One subject reported an increasingly severe headache during 45 seconds of exposure to the smart meter and was forced to discontinue. The post-exposure blood cell sample of this subject exhibited 'rouleau', a condition in which the cells clump together in a stack formation, causing a decreased capacity for oxygen transport by the blood. Of the other two serum samples of cells shown, one exhibited significant degradation to the cell membranes and 'mycoplasmic'-like changes in the cells; the other also displayed degradation of cell membranes called 'bottle cap' formation, which it is known can occur due to oxidation or exposure to free- radical species. All of these changes occurred with RF radiation from the smart meter as the only variable.

With regard to the relative percentages of people who do, versus people who do not, consciously experience or report adverse effects of exposure to RF radiation from smart meters, one of the experimenters, Dr. Frank H. Springob, DC, answered the interviewer's question with the following assertion: "***There are changes, whether they feel them or not***. Maybe they're not out there complaining about it or trying to make other people aware of what it's doing to them, yet ***they're still being affected*** by it."

EXHIBITS 31B-1 , 31B-2 and 31B-3 (FD):
Dark-field photomicrographs of before (**EXHIBIT 31B-1**) and after (**EXHIBIT 31B-2**) exposures of test subjects to wireless smart meter under the conditions described in **EXHIBIT 31A**.

EXHIBIT 31C (FD):
'Live Blood Analysis' Dr. Magda Havas, PhD, Associate Professor of Environmental & Resource Studies, Trent University. Images viewed through microscope of samples of Dr. Havas' own blood taken before and after exposures to RF radiation and RF electromagnetic fields.

EXHIBIT 38A (FD):

Demonstration. Measurement of RF radiation power densities several feet from a bank of smart meters. The maximum measurement obtained during less than 3 minutes of recording was 38,900 microwatts per square meter, which converts to 3.89 microwatts per square centimeter. This RF power density value *exceeds* the power density values specified in thirty-eight (38) of the studies listed in **EXHIBIT 37** showing biological effects. The frequent pulsed transmissions, or bursts, of radiofrequency radiation are easily and clearly made audible and visually observable by the meter instrument used.

EXHIBIT 38B (FD):
Smart Electric Meters. Overview of measurement readings of 3 **Landis+Gyr Focus AXR-SD** smart meters taken by Oram Miller, BBEC, EMRS Certified Building Biology Environmental Consultant and Electromagnetic Radiation Specialist. Reads in part:

"Here are photos of two readings I obtained during micro-bursts of radio frequency transmission during a beacon signal from the Landis+Gyr smart meter. In the first photo below, the detector screen reads, "898." This signifies a radio frequency power density, or strength, of 89,800 microWatts/meter squared ... .

"The second photo shows a situation where the screen is blank, except for a vertical mark on the left (which is not the number "one"). This signifies that the RF detector is reading a radio frequency level that *exceeds* the limit of this RF detector with the attenuator in place, which is 200,000 microWatts/meter squared:

"This means that the Landys+Gyr smart meter being measured at a house in Morro Bay in the Pacific Gas & Electric service area is sending out radio frequency microbursts in excess of 200,000 microWatts/meter squared at three feet ... . I have also measured radio frequency power density levels from smart electric meters around the country that are as high as those measured in Central and Northern California."
...
"I measured two more Landys+Gyr smart electric meters at homes in Templeton, just east of Morro Bay and north of San Luis Obispo. I did not take photographs of those measurements, but I measured power density levels at three feet from these PG&E Landis+Gyr smart meters at levels that ranged from 160,000 microWatts/meter squared (uW/m^2) to in excess of 200,000 uW/m^2, the level that again *exceeds* the ability of my Gigahertz Solutions HF35C radio frequency detector to measure."

"[I]t is *well* above the 'Extreme Concern' level as determined by the building biology profession and many other independent sources of only 1,000 uW/m^2.

"Furthermore, when I stepped back to 8 feet from the two PG&E Landys+Gyr smart meters in Templeton, I still measured readings as high as 54,000 uW/m^2. When I moved further back to 30 feet from the smart meter, the reading reduced to 160 uW/m^2."

EXHIBIT 38C (FD):
Demonstration. Rough test of radiofrequency radiation peak levels emitted by a **Landis+Gyr Focus AXR-SD** smart meter as compared to RFR peak levels emitted by a cell phone during an active call. The RF measuring device used was hand-held at approximately the same distance of one (1) foot from each RF transmitting device.

In the demonstration, the maximum RF radiation power density reached by the cell phone was 981 µW/m^2, which equates to .0981 µW/cm^2. **The maximum RF radiation power density reached by the Landis+Gyr smart meter was 539,400 µW/m^2**, or 53.94 µW/cm^2, **which is approximately 540 times the maximum RF radiation power density produced by the cell phone**.

Although the RF radiation measuring device that was used certainly was not the most sophisticated available, **the important fact to consider is that this same device was used to measure and compare the emissions of both RF transmitting devices from approximately the same distance**.

The maximum RF power density of 53.94 µW/cm^2 produced by the smart meter and measured in the demonstration equates also to .05394 mW/cm^2. This RF ***peak-power*** density value is approximately **146 times** the 30-minute ***average*** power density value of "0.00037 milliwatt per square centimeter" specified in the Pennsylvania Public Utility Commission's *Smart Meter Q&A* fact sheet (**EXHIBIT 28**). The *Smart Meter Q&A* fact sheet, however, fails to specify the distance from the smart meter at which the given RF power density value was measured.

The measurements in the demonstration showing greater RF power density of the smart meter emissions in comparison to RF power density of the emissions from the cell phone are not inconsistent with the following statements by the California Department of Public Health (CDPH) concerning its own field measurements:

"Cell phones emit much lower emfs that are closer to those of the Smart Meters. Our measurements of emissions from many cell phones (directly next to the device) under a variety of weak and strong signal conditions all fall under 80 micro watts per square centimeter; often much lower. **Frequently, these cell phone emissions are lower than the 40 micro watts per square centimeter shown for the smart meter at 3 feet**." (Ref. **EXHIBIT 29C-2.**) (Underlining and emphasis added.)

It is quite possible, even likely, depending on the location and placement of their beds inside their homes, that there are many people who unknowingly are spending eight or more hours per 24-hour day within approximately one foot from an RF-transmitting smart meter.

EXHIBIT 38D (FD):
WUSA-9 television news report that smart meters emit bursts of microwave radiofrequency radiation far more frequently than electric utility has claimed.

EXHIBIT 38E : Demonstration of transmission frequency of Landis+Gyr Focus AXR-SD AMI smart meter installed locally by Respondent, PPL Electric Utilities. RF Meter in video displays at least thirteen (13) distinct transmission pulses or bursts over a continuous 3-minute time interval starting from the 1-minute mark and ending at the 4-minute mark. This rate of transmission pulses averages to more than four (4) transmissions per minute. The corresponding total transmission time per day of radiofrequency transmissions by PPL's AMI smart meter in this case would be at least four (4) times the total transmission time per day calculated from the information provided by PPL to Complainants in the company's answers to Complainants' Interrogatories.

EXHIBIT 46L-3 (FD):
***Evaluation of the Landis+Gyr AMI Meter*.** William S. Bathgate, EE, ME. Pages 19, 26 read in part:

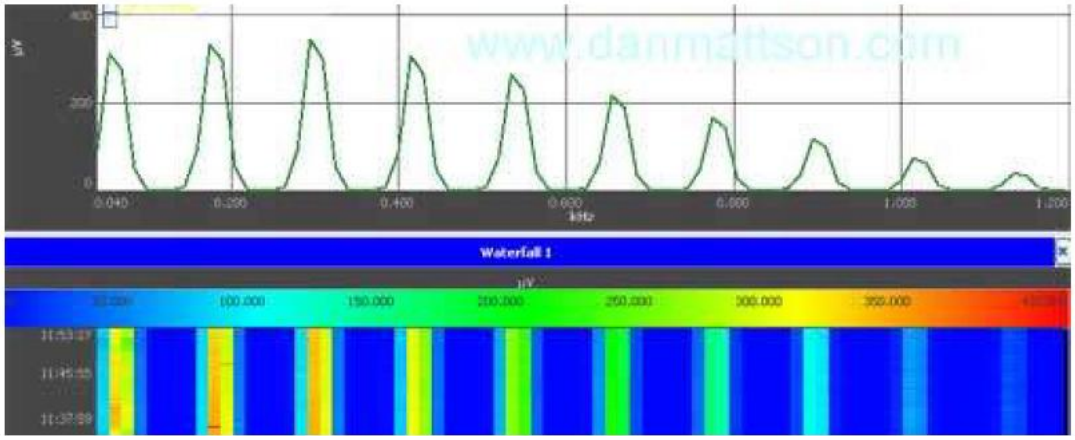
"The AMI meter, Opt-Out Meter and various versions of the Electronic meters all currently exhibit spiked high frequency voltage transients and magnetic common mode currents backwards onto the home wiring system creating a huge antenna amplifying these transients and magnetic currents."... This weakness is due to "the lack of a common mode and differential filtering of the SMPS oscillations being injected from the meter onto the house wiring circuit, thus *making the whole house into an antenna with dangerous RFI/EMI*." (Underlining and italics added.)

EXHIBIT 46L-4 (FD):
Testimony of electrical engineer, William S. Bathgate, before Michigan House Energy Committee smart meter Bill 4220 hearing (Feb. 21, 2017). In this testimony excerpt, Mr. Bathgate presents a graph of conducted emissions produced by a switching mode power supply (SMPS), a component present in each and every digital wireless smart meter, irrespective of make or model. Conducted emissions,

or high-frequency voltage transients, produced by all wireless smart meters, are introduced and propagated by the meters into and through the wire circuits of the homes and building structures on which they are installed.

EXHIBIT 46L-5 (FD):
The Landis+Gyr Smart Meter: An Inside View. Analysis prepared by Dan Mattson, EMF Technician, reads in part:

"Linear reactive loads do not cause distortion to the sinewave power waveform. Non-linear loads do. **The SMPS is such a load**. What makes a SMPS a nonlinear reactive load is a circuit combination of a diode and capacitor together."
...
SMPS harmonic distortion signatures



Landis + Gyr smart meter signature

"Nonlinear loads do create a signature. The waveform above shows harmonic distortion. This is a first step but not the whole story. To reveal the signature, this must be analyzed for the harmonic content. This signature will be unique to individual devices.

"This is a spectrum analyzer view of the harmonic distortion in the smart meter current waveform shown above. All non-linear loads, such as switching power supplies, produce such an image and all of them are unique."
...
"This paper presents evidence based on manufacturer specifications and field measurement that the switching frequency of a Landis + Gyr smart meter SMPS is about 130 kHz. Further, that **this creates a harmonic rich signal that is readily induced in the hot legs of a 100-amp residential service entrance. Evidence from field measurement is also presented showing that this harmonic-rich switching frequency is radiated *from the meter*.**" (Underlining, emphasis and italics added.)

EXHIBIT 46L-2 (FD):
Direct Testimony of electrical engineer William S. Bathgate, EE, ME, before the Michigan Public Service Commission (U-18255-0224), August 29, 2017. Includes discussion of characteristics common to all AMI wireless smart meters:

"**Q. Does DTE Energy's failure to independently test AMI meters put customers at risk? If so, how?**

"A. The AMI Meter Switched Mode Power Supply (SMPS) design is lacking what is called a differential voltage and common mode current filter circuit to keep it from back-feeding high frequency voltage transients and magnetic currents as an electrical by-product onto the home primary wiring circuits. See **Exhibit RCG-03** (WSB-03) and **Exhibit RCG-05** (WSB-05). The result is magnetic fields and high frequency radio emissions surrounding every room. This class of emissions is called EMI/RFI (commonly called EMC) and is viewed by the FCC as Conducted Emissions. The FCC has limits for Conducted Emissions (please note not the mesh network RF meter reading emissions) and any electronic device that has Conducted Emissions in excess of 9 KHz switching oscillators must comply with FCC conducted emissions specifications. See **Exhibit RCG-08** (WSB-2 08). There are two classes of devices, Class A for industrial application and Class B which is more stringent for computer based applications. The AMI meter has a computer CPU and Memory just like any PC has, and therefore FCC Class B regulations apply. No AMI meter used by DTE Energy has been independently tested to ensure compliance with the FCC recommended line impedance stabilization network ("LISN") test equipment. LISN tests are done by third parties on behalf of manufacturers and provide manufacturers public documented assurance their products comply with FCC Conducted Emissions standards. Nor has DTE Energy published any LISN test results for Conducted Emissions from an independent third party. This would be very difficult to achieve because an LISN test setup requires a ground reference. There is no ground connection to the SMPS so it would likely not be able to be tested per FCC Specifications for conducted emissions. It is important to note that these tests must be performed under varying loads and with typical home appliances, not by some backroom lab at idle current, because when current demand is applied the variations in Conducted Emissions are exacerbated.

"My testing has shown that Conducted Emissions far exceed FCC limits with typical peak to peak voltages of 14-19 Volts and at frequencies ranging from 2 KHz to 36 MHz In addition, I have found through testing a home under load that measured in excess of 27 Volts peak-to-peak at frequencies exceeding 40 MHz max. See **Exhibit RCG-08** (WSB-21 08). The oscilloscope trace I have provided is a typical home with no branch circuits active and only measuring the Conducted Omissions (sic) from only the AMI meter. As noted in the oscilloscope trace, the

frequency of the emissions varies dramatically in phase with the 60 Cycle AC. This makes it very problematic to state that the emissions are of a certain fixed frequency, because they are constantly varying. This makes mitigating these emissions downstream from the AMI meter (with high amperages in the home requiring multiple low pass limits to allow only the 60 cycle frequency to be present) extremely expensive to procure, exceeding $7,000. All medical facilities and data centers used by the US DoD place these filters in line with the main electric service classified in Mil Spec MIL-STD-461F NCE02 for 10 KHz to 10 MHz (see attached **Exhibit RCG-09** (WSB-09) http://incompliancemag.com/article/design-practices-for-military-emc-and-environmental9 compliance/).

"Based on these standards no AMI meter could ever be directly connected to the primary building wiring of sensitive facilities such as a senior health center, doctors office, hospital or emergency center without an EMC mitigating high voltage and high amperage low pass filter between the utility source and the buildings load panels. Every medical office has many highly sensitive electronic equipment such as EKG and X-ray equipment that are subject to the deleterious effects of these high conducted emissions which can degrade equipment or affect the reading and operational life of this type of equipment. Yet the utility has proceeded to install AMI meters in these facilities and not notified the owners of these businesses of the conducted emissions risks they now are subject to as the result of installing an AMI or Opt-Out meter.

"Unfortunately the only fix for the conducted emissions from the SMPS is a complete redesign with a connected wire ground reference. This would effectively cause a redesign of the AMI meter. The other option is an Analog Meter.

"**Q. Are DTE Energy's residential customers similarly at risk, particularly those operating medical equipment?**

"A. Yes, the same is true for households for residents with life sustaining electronic equipment such as the following:

Tank type Respirator (Iron Lung)
Cuirasses Respirator (Chest Respirator)
Rocking Bed
Electrically operated Respirator
Suction Machine (Pump)
Hemodialysis Equipment (Kidney Machine)
Intermittent Positive Pressure Respirator
Special Air Conditioning (specific humidity control)
Heart Rate Monitor

PD APENA Monitor (Parkinson's disease control)
Diaphragm Stimulator
Oxygen Concentrator
Medical Pump
Press Respirator (for Hypertension treatment)
CP Drum ventilator (for particulate filtering for persons with Cystic Fibrosis lung diseases)

"All this essential medical equipment will either unexpectedly fail operation in an unpredictable manner or be unpredictably compromised from normal operation when subjected to the level of Conducted Emissions present in the AMI meter in use by DTE Energy, or any other utility. A person with a sensitive condition could die or suffer a serious degraded health from a critical device failure.

"**Q. How can the Commission address and alleviate the risks you have described?**

"A. The only means to prevent harm to the residents of homes and certain medical offices is the elimination of the AMI installation and replacement with an Analog Meter." (pp. 11-15.) (Underlining added.)

2. Exhibits and Partial Transcripts of Medical and Scientific Sources and Letters by U.S. EPA Affirming Inapplicability of FCC Safety Guidelines to Non-thermal Mechanisms of Interaction

This section includes the following:

Exhibit Nos. 4A, 4B, 4C, 4E, 4F, 4H, 4I, 30E, and 42B-1.

All of the exhibits listed within this section constitute directly relevant and highly credible evidence of absolutely and completely reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

The following exhibits which include letters from the U.S. Environmental Protection Agency and recommendations to the FCC by the EPA, put to rest any claim that the FCC's safety guideline for 'maximum permissible exposure' (MPE), based upon whole-body averaged SAR, is an appropriate or applicable standard of protection against non-thermal, or sub-thermal, biological effects of exposure to non-ionizing, low-level radiofrequency radiation:

EXHIBIT 4A (FD):
Letter from Dr. Norbert Hankin, PhD, Center for Science and Risk Assessment, and Frank Marcinowski, Director, Radiation Protection Division, U.S. Environmental Protection Agency, 2002. Reads in part:

"The FCC's current exposure guidelines, as well as those of the Institute of Electrical and Electronics Engineers (IEEE) and the International Commission on Non-ionizing Radiation Protection, are thermally based, and **do not apply to chronic, nonthermal exposure situations**. They are believed to protect against injury that may be caused by acute exposures that result in tissue heating or electric shock and burn. ... **The FCC's exposure guideline is considered protective of effects arising from a thermal mechanism but not from all possible mechanisms.** Therefore**, the generalization by many that the guidelines protect human beings from harm by any or all mechanisms is not justified.**" (Underlining and emphasis added.)

EXHIBIT 4B (FD):
U.S. Environmental Protection Agency recommendations to the FCC (ET Docket No. 93-62) **against** adopting the **1992 ANSI/IEEE safety standard for RF**, stating that the standard **"has serious flaws that call into question whether its proposed use is sufficiently protective of public health and safety."**

These recommendations were written when there still were top-ranking officials at the EPA with integrity and credibility and also courage enough to openly advocate, on the basis of sound science, in the genuine best interest of the public as opposed to industry. That is, these recommendations were made prior to the EPA's becoming, like the FCC and the FDA, entirely a "captured agency"—subservient to industry power and influence such that public health and safety are now hostage to corporate interests. The EPA's recommendations nonetheless still directly and entirely apply to the current FCC (1992 ANSI/IEEE standard) guidelines and read in part:

[EPA to FCC - Begin quote]

In accordance with its responsibilities under Section 309 of the Clean Air Act (CAA), the Environmental Protection Agency (EPA) is pleased to submit comments to the Federal Communications Commission (FCC) on the Notice of Proposed Rulemaking (NPRM), Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation, ET Docket No. 93-62. This proposal, if adopted, would use the 1992 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE) standard to update and amend the FCC guidelines for evaluating the environmental effects of radiofrequency (RF)

radiation emitted by FCC-regulated facilities on public health and safety.

The 1992 ANSI standard represents a significant revision of the earlier 1982 ANSI standard. ... **EPA recommends against adopting the 1992 ANSI/IEEE standard because it has serious flaws that call into question whether its proposed use is sufficiently protective of public health and safety**.

To have a more protective public exposure standard, EPA recommends that the FCC instead adopt the exposure criteria recommended earlier by the National Council on Radiation Protection and Measurements (NCRP) in their report entitled "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields (NCRP 1986)."

...

EPA recommends the following:

1. The FCC should not adopt the 1992 ANSI/IEEE standard. There are serious flaws in the standard that call into question whether the proposed use of the 1992 ANSI/IEEE is sufficiently protective. The following four points address several key Agency concerns.

a. The 1992 ANSI/IEEE allows a two-fold increase in the MPE at high frequencies above that permitted by the current FCC guideline.

b. The two-level revised standard is not directly applicable to any population group but is applicable to exposure environments called "controlled" and "uncontrolled" environments that are not well defined and are discretionary. The Agency disagrees with this approach.

c. **The 1992 ANSI/IEEE conclusion that there is no scientific data indicating that certain subgroups of the population are more at risk than others is not supported by NCRP and EPA reports**.

d. **The thesis that the 1992 ANSI/IEEE recommendations are protective of all mechanisms of interaction is unwarranted because the adverse effects level in the 1992 ANSI/IEEE standard is based on a thermal effect**.

...

Environmental Protection Agency (EPA) Comments to the Federal Communications Commission (FCC) on FCC 93-142, April 1993, Notice of Proposed Rulemaking; Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation.

Introduction

...

EPA review of 1992 ANSI/IEEE leads us to believe that it is a standard with flaws that cast doubt about whether it is sufficiently protective of public health

and safety, and its claim that "the recommended exposure levels should be safe for all."

...

Discussion

Approach to Derivation of Standards

The rationale provided in ANSI/IEEE to explain fundamental characteristics of the 1992 ANSI/IEEE guidelines, in many cases, lacks explanation, consistency, and well-founded justifications. In addition, there is concern that the complexity of the 1992 ANSI/IEEE standard may make it difficult to comply with or effectively enforce.

...

When available, human data is preferable to laboratory animal data in standards development. Therefore we consider the 1992 ANSI/IEEE guidelines to be deficient in this area because reports published after 1986 that presented human data were not considered. We would expect that future efforts to develop or update RF radiation standards would include analysis of available human thermophysiological information and models.

Claim of Protection for All Persons from All Interaction Mechanisms

The new ANSI/IEEE standard states that the "intent was to protect human beings from harm by any mechanism, including those arising from excessive elevations of body temperature" (IEEE p.27), i.e., the 1992 ANSI/IEEE standard is purported to be protective of all persons and all interaction mechanisms. We believe that this position has not been supported, as shown by the following discussion.

In the 1992 ANSI/IEEE standard, as well as in the 1986 NCRP guidelines, the biological basis for maximum permissible exposure level varies with frequency. In the frequency range from 100 kHz to 6 GHz, maximum permissible exposure levels are based on whole-body averaged SAR (specific absorption rate expressed in watts per kilogram of body mass, W/kg). More specifically, the working threshold for unfavorable biological effects in human beings in the frequency range from 100 kHz to 6 GHz is defined as 4 W/kg. Safety factors of 10 and 50 were used to derive the maximum permissible exposures for controlled and uncontrolled environments, respectively.

This adverse effect level for human beings, 4 W/kg, is the threshold for a specific biological effect, i.e., behavioral disruption (work stoppage) in nonhuman primates that is associated with an increase in body temperature. Work stoppage, the failure of a food-deprived animal to perform a learned task to gain a food reward, is interpreted to result from thermal stress, caused by the absorption of RF energy,

that is sufficiently severe to deter hungry animals from working for food.

Since the ANSI/IEEE hazard level is an SAR associated with an effect resulting from a known mechanism of interaction (RF heating) that is associated with an increase in body temperature (as is the NCRP hazard level), **the ANSI/IEEE C95.1-1992 standard is based on a thermal effect of RF radiation and, by extension, is protective of effects arising from a thermal mechanism, but not from all possible mechanisms**. **Therefore, the generalization that 1992 ANSI/IEEE guidelines protect human beings from harm by any mechanism is not justified**.

In contrast to the 1992 ANSI/IEEE standard, **1986 NCRP states that a response to RF radiation may have a "thermal basis, an athermal basis, or a combined basis," and that a "determination of which of these three classes of causation is operative in a given context rests upon appropriate experimentation and inference, not presumption."** NCRP also claims that there is "no intent to define exposure criteria solely in terms of SAR," and that **"consideration is also given to other factors where appropriate." These factors include, among others, possible modulation- and carrier-frequency specific biological responses**.

Exposure Environments - Controlled and Uncontrolled

EPA believes that the proper approach in defining exposure environments to which guidelines are applied should be in terms of the populations to be protected, i.e., the traditionally defined populations being workers and the public. However, the ANSI/IEEE standard takes a different approach.

The 1992 ANSI/IEEE standard recommends exposure limits for a controlled environment and an uncontrolled environment. Controlled environments are defined as locations where exposure may be incurred by persons who are aware of the potential for exposure or as the result of transient passage. Uncontrolled environments are locations where exposures may be incurred by persons who are unaware of the potential for exposure. In the uncontrolled environment, an additional safety factor is applied for exposure in the resonant frequency range and for low-frequency exposure to electric fields. As defined in the standard, controlled environments are discretionary, i.e., identification of controlled environments is at the discretion of the operator of a source (see IEEE, p. 9, footnote 1).

The 1992 ANSI/IEEE standard states clearly that the distinction between the two exposure environments is based on the nature of the exposure environment and not on the population type (see IEEE 1991, p- 23). **ANSI/IEEE does not allow for any variation in sensitivity to RF radiation. It states that there is no reliable evidence that certain subgroups of the population [such as infants, aged, ill**

and disabled, persons dependent on medication, persons in adverse environmental conditions (excessive heat and/or humidity), voluntary vs. involuntary exposure] are more at risk than others (IEEE 1991, p. 23). **This conclusion is not in agreement with conclusions in the EPA report "Biological Effects of Radiofrequency Radiation" (EPA 600/8- 83-026F, 1984) or in the NCRP Report No. 86, "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields"** that the general population has groups of individuals particularly susceptible to heat.

Other contemporary guidelines agree with NCRP and EPA; the Food and Drug Administration (FDA) 1988, National Radiological Protection Board (NRPB) 1991, International Radiation Protection Association (IRPA) 1991, and the International Electrotechnical Commission (IEC) 1993, guidelines define groups of people who are less heat tolerant than others. These include the elderly, infants, pregnant women, and people who are obese, have hypertension, or take drugs such as diuretics, tranquilizers, sedatives, or vasodilators that decrease heat tolerance.

The basis for the ANSI/IEEE guideline in the frequency range of 0.1 MHz to 6.0 GHz, the frequency range in which most of FCC licensed transmitters operate, is an effect due to RF heating. Since, as mentioned above, the general population contains individuals particularly susceptible to heat, we recommend against the use of controlled and uncontrolled environments and recommend consideration of 1986 NCRP as a means of avoiding this problem.

We strongly disagree with the use of the concepts of control and awareness in the discretionary manner presented in 1992 ANSI/IEEE. In the standard there are no firm rules given to differentiate between controlled and uncontrolled environments, and therefore the concept will be difficult to apply because people seldom agree on discretionary areas of exposure. The standard could be applied arbitrarily and inconsistently since ANSI/IEEE does not impose conditions to describe or create the state of awareness. An individual's degree of awareness could vary from complete understanding of RF sources to only a vague awareness that RF radiation exists in his controlled environment.

If awareness in a controlled environment can vary from complete knowledge to almost no knowledge, then the degree of control over safety is uncertain. Unspecified awareness in itself does not constitute a controlled situation. A controlled environment could be established with measures imposed to ensure strict adherence to the standard to prevent the possibility for exposure of any individual in the controlled environment to exposures greater than recommended by the standard. However, 1992 ANSI/IEEE does not recommend the actions that should be taken to establish a controlled environment, and if it would, it could not provide the authority for control. In our view, "awareness" is not equivalent to protection.

... NCRP recognizes that **there is variability in human response, that there are categories of individuals with susceptibilities that place them at greater risk for potential harm**, and that workers, **who may be relatively well informed of potential hazards of RF radiation exposure, may have the opportunity to make personal decisions in regard to their exposure**. Therefore it is appropriate for the FCC to adopt this approach to apply the more conservative guidelines where there is any question of possible exposure of the general public (which might also include nontechnical employees) to RF radiation, and to apply the more restrictive exposure limits to any transmitters and facilities that are located in residential areas or locations where the RF source may be accessible to the public. We suggest that the phrase "accessible to the public" replace the word "unrestricted" in the FCC proposal because the former phrase more accurately describes the locations.

Limitations of data

Availability of chronic exposure information

It is clear that the adverse effect threshold of 4 W/kg is based on acute exposures (measured in minutes or a few hours) that elevate temperature in laboratory animals including nonhuman primates, and not on long-term, low-level (non-thermal) exposure. ...

The limitations of the data used to define the adverse effect level in the 1992 ANSI/IEEE recommendations do not support the claim that the recommended MPEs in 1992 ANSI/IEEE are protective of all mechanisms and all people.

...

Extremely Low Frequency (ELF) -Modulated RF Radiation

As noted in the FCC proposal (paragraph 25), the NCRP guidelines - include a special provision with respect to exposure of workers to RF carrier frequencies modulated at ELF frequencies. **This recommendation is apparently based on experimental results showing neurophysiological effects of modulated fields**. The modulation provision for workers in the NCRP guidelines is unique; no other RF exposure guideline contains such a provision. For certain modulation conditions, the exposure criteria for occupational exposures is the generally 10-fold more stringent general population exposure criteria.

While studies continue to be published describing biological responses to nonthermal ELF-modulated RF radiation, the effects information is not yet sufficient to be used as a basis for exposure criteria to protect the public against adverse human health effects.

Pulse-modulated vs. continuous-wave (CW) RF radiation

Many other studies provide evidence that nonthermal modulated-RF exposures produce effects that are not produced by CW (unmodulated) RF radiation. Meaningful studies of biological and health effects of nonthermal, pulse-modulated RF radiation exist including studies that show injury to the eye (Kues et al., Johns Hopkins Applied Physics Laboratory (JHAPL). The significance of these results, even at the early stages of this continuing research, was responsible for the development and adoption of an RF radiation exposure standard by JHAPL (in 1984) for their personnel. The JHAPL MPE for frequencies from 30 MHz to 100 GHz is 0.1 mW/cm^2. This standard provided the basis for the 0.1 mW/cm^2 action level used to protect personnel from harm from RF radiation-generating equipment at the Hughes Aircraft Company. The JHAPL MPE is a factor of 100 times more stringent than the 1992 ANSI/IEEE MPE for controlled environments for the frequency range of 3.0 GHz and above.

Pulse-modulated RF radiation can produce a response that is called "microwave hearing". This effect seems well established and probably results from very rapid thermoelastic expansion of the brain, creating a sound wave in the head. **Conditions under which the auditory effect can be invoked in people with normal hearing should be avoided according to the National Radiological Protection Board (NRPB) draft recommendations for workers and the public**. **In contrast to this recommendation, the 1992 ANSI/IEEE standard states that the human auditory effect is clearly not deleterious; it recommends a limit for pulsed radiation that is well above the threshold for the auditory effect**.

Low-power Devices

We recommend that the two population groups, workers and the public, be used in the following suggested modifications to the FCC proposal regarding exposure to hand-held devices and amateur radio facilities (see FCC 1993, p.6, footnote 16). Non-users exposed to hand-held devices and amateur radio facilities should be considered as the public. Users of hand-held devices and amateur radio facilities should be considered as the public unless the user is operating a device as a concomitant of employment. This recommendation is based on the difficulty of differentiating between individuals who are cognizant or noncognizant of the potential for RF exposure and is consistent with the NCRP recognition of the two population groups, workers and the public. If NCRP is used, the problem of differentiating between cognizant workers and cognizant public would be avoided, and it would not be necessary to distinguish between users and non-users.

Other Contemporary Radiofrequency Radiation Guidelines

In addition to the differences identified and discussed between the 1992 ANSI/IEEE standard and the 1986 NCRP recommendations, **there are significant differences between 1992 ANSI/IEEE and other contemporary RF radiation exposure guidelines, including those of the Food and Drug Administration (FDA), National Radiological Protection Board (NRPB), International Radiation Protection Association (IRPA), the International Electrotechnical Commission (IEC), and the Johns Hopkins Applied Physics Laboratory (JHAPL)**. The comments in this section address some of the differences.

The 1992 ANSI/IEEE guidelines are based on literature published before 1986 except for several papers on shock and burn. ...

The 1992 ANSI/IEEE standard claims that the recommendations protect against harm by any mechanism, that is, both thermal and nonthermal. **It contends that chronic exposure data and information on nonthermal interactions are not meaningful for standards development**. ... **EPA does not agree with the claim that the 1992 ANSI/IEEE guidelines protect against effects of any mechanism**; **we believe that the only claim that can be made is that the 1992 ANSI/IEEE standard applies only to thermal effects and electric shock**.

...

The 1993 NRPB draft recommendations for workers and the public state that restrictions on acute exposure to RF radiation of frequencies greater than 100 kHz are intended to avoid adverse effects resulting from whole-body and partial-body heating, **and adverse effects resulting from pulsed RF radiation**.

The 1992 ANSI/IEEE standard recommends limits for controlled and uncontrolled environments, using as its basis the position that the it is the nature of the exposure environment, not population type, that is important. This position is based partially on the conclusion that no reliable scientific data exists indicating that certain subgroups of the population are more at risk than others. However, **other contemporary guidelines state the opposite conclusion**. **The FDA (1988), NRPB (1991), IRPA (1991), and the IEC (1993) guidelines** define groups of people who are less heat tolerant than others.

This information should be considered in development of an exposure standard.

Summary of EPA Recommendations

1. **The FCC should not adopt the 1992 ANSI/IEEE standard**. **There are serious flaws in the standard that call into question whether the proposed use of 1992 ANSI/IEEE is sufficiently protective**. The following four points address some of our concerns.

a) 1992 ANSI/IEEE allows a two-fold increase in the MPE at high frequencies above that permitted by the current FCC guideline.

b) The two-level revised standard is not directly applicable to any population group but is applicable to exposure environments called controlled and uncontrolled environments that are not well defined and are discretionary. We disagree with this approach.

c) <u>The 1992 ANSI/IEEE conclusion that there is no scientific data indicating that certain subgroups of the population are more at risk than others is not supported by NCRP and EPA reports</u>.

d) **<u>The thesis that the 1992 ANSI/IEEE recommendations are protective of all mechanisms of interaction is unwarranted because the adverse effects level in the 1992 ANSI/IEEE standard is based on a thermal effect</u>**.

2. The FCC should consider the exposure criteria recommended by the National Council on Radiation Protection and Measurements (NCRP) in NCRP Report No. 86, "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," with the addition of

...

EPA recommends consideration of 1986 NCRP for the following reasons.

e) 1986 NCRP recommends RF radiation exposure limits specifically for both workers and the public.

f) 1986 NCRP is more protective than 1992 ANSI/IEEE at higher frequencies.

...

In addition, **NCRP is chartered by the U.S. Congress to develop radiation protection recommendations**.

3. The FCC should consider requesting that the NCRP revise its 1986 report to provide an updated, critical, and comprehensive review of the biological effects on RF radiation and recommendations for exposure criteria.

(Underlining and emphasis added.)

[EPA to FCC - End quote]

EXHIBIT 4C (FD):

Letter by Dr. De-Kun Li, MD, PhD, MPH, Senior Scientist, Kaiser Permanente Division of Research, concerning smart meters, radiofrequency radiation, health effects and safety guidelines. Dr. Li's letter includes a clear and direct statement on the irrelevance and fallacy of applying the present FCC safety guidelines, which pertain **only** to acute and/or thermal levels of exposure to RF, as a standard of protection from non-thermal or a-thermal exposures to RF radiation.

Reads in part:

"Many chronic diseases that the public is concerned about (e.g., cancer) have a long latency period and take decades to show symptoms. Most wireless network and devices have only been used widely in the last 10 to 15 years. Therefore, **many studies evaluating RF health effect related to cancer risk previously, if they failed to identify an adverse health effect, are not appropriate to be used as evidence to claim the safety of RF exposure since the latency period has not been long enough to show the effect even if an adverse association does indeed exist**."

...

"While the underlying mechanisms of the potential EMF health effect are not totally understood at present, skeptics have been focused on the EMF thermal effect, especially those who are NOT in the profession of biomedical research, such as physicists. **It is now known that EMFs can interfere with the human body through multiple mechanisms**. For example, **it has been demonstrated that communication between cells depends on EMF signals, *likely in a very low level***. External EMFs could conceivably interfere with normal cell communication, thus disrupting normal cell differentiation and proliferation. Such disturbance could lead to miscarriage, birth defects, and cancer."

...

"Meeting the current FCC guidelines, in the best-case scenario, only means that one won't have heat damage from SmartMeter exposure. It says nothing about safety from the risk of many chronic diseases that the public is most concerned about such as cancer, miscarriage, birth defects, semen quality, autoimmune diseases, etc. Therefore, **when it comes to non-thermal effects of RF, which is the most relevant effect for public concerns, FCC guidelines are irrelevant and can not be used for any claims of SmartMeter safety unless we are addressing heat damage.**"

...

"**The bottom line is that the safety level for RF exposure related to non-thermal effect is unknown at present and whoever claims that their device is safe regarding non-thermal effect is either ignorant or misleading**." (Underlining, italics and emphasis added.)

[End of Li letter]

EXHIBIT 4E (FD):
Letter from the Director, Office of Environmental Policy and Compliance, U.S. Department of the Interior, to the National Telecommunications and Information Administration, U.S. Department of Commerce. Enclosure A of this communication reads in part:

"915 MHz is the standard cellular phone frequency used in the United States. However, **the electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today**. This is primarily due to the lower levels of radiation output from microwave-powered communication devices such as cellular telephones and other sources of point-to-point communications; levels typically lower than from microwave ovens. **The problem, however, appears to focus on very low levels of non-ionizing electromagnetic radiation**. For example, in laboratory studies, T. Litovitz (personal communication) and DiCarlo *et al.* (2002) raised concerns about impacts of low-level, non-thermal electromagnetic radiation from the standard 915 MHz cell phone frequency on domestic chicken embryos – **with some lethal results** (Manville 2009, 2013a). **Radiation at extremely low levels (0.0001 [one ten-thousandth] the level emitted by the average digital cellular telephone) *caused* heart attacks and the deaths of some chicken embryos** subjected to hypoxic conditions in the laboratory **while controls** subjected to hypoxia **were unaffected** (DiCarlo *et al.* 2002)." (Underlining, italics and emphasis added.)

EXHIBIT 4F (FD):
https://ehtrust.orgwp-contentuploads827eb44b0a8e5417c3fa1858ab61bc11.pdf
Letter from U.S. EPA health physicist, George P. Brozowski, stating that with regard to the FCC safety guidelines on radiofrequency radiation exposure: "The standards are intended to prevent adverse health effects that may be associated with tissue heating, but **are not intended to address low intensity (non-thermal), long-term (chronic) exposures**." (Underlining and emphasis added.)

The U.S. Food and Drug Administration, FDA, is on record in a communication to the FCC, dated November 10, 1993, stating that the "FCC's rules do not address the issue of long-term, chronic exposure to radiofrequency fields."

The National Institute for Occupational Safety and Health, NIOSH, has stated that the FCC's proposed standard was inadequate because it "is based on only one dominant mechanism—adverse health effects caused by body heating."

EXHIBIT 4H (FD):
Handbook of Biological Effects of Electromagnetic Fields, Third Edition: Biological and Medical Aspects of Electromagnetic Fields. 2007. Edited by Dr. Frank S. Barnes, PhD, Electrical Engineering, Stanford University, distinguished professor, University of Colorado, and Dr. Ben Greenebaum, PhD, Physics, Harvard University, Professor of Physics, University of Wisconsin, and editor-in-chief of the international peer-reviewed scientific journal, *Bioelectromagnetics*. According to the authors, "This [text]book contains information obtained from authentic and highly regarded sources."

Section 11.3.9 of the text, entitled *Dosimetry for Induced Electric Fields* (pp. 414-415 of PDF file), reads in part:

"The biophysical lore prevailing until the late 1980s and lingering to this day is that, unless the amplitude and frequencies of an applied electric field were sufficient to trigger an excitable membrane (e.g., heart pacemaker), produce tissue heating, or move an ion along a field gradient there could be no effect. This was a formidable obstacle in the quest for therapeutic applications of weak EMF signals. **However, this position had to be changed as the evidence for weak (nonthermal) EMF bioeffects became overwhelming. The clinical evidence offered by many double-blind clinical studies coupled with the database of hundreds of thousands of successful treatments** of delayed and nonunion bone fractures **registered with the FDA simply could no longer be ignored**. Noninvasive PEMF treatment is actually as successful as the first bone graft to the huge benefit of the patient. The task now was to provide solid testable models for the biophysical mechanism of weak electric field bioeffects."
...
"Without resorting to signal processing or metabolic amplification, it is still necessary to attempt to understand **the remarkable sensitivity of biological systems to weak electric fields**." (Underlining and emphasis added.)

EXHIBIT 4I (FD):
Letter, dated August 29, 2013, from the American Academy of Pediatrics to the Commissioner and Acting Commissioner of the Federal Communications Commission (FCC). https://ecfsapi.fcc.gov/file/7520941318.pdf

Reads in part:

"Current FCC standards do not account for the unique vulnerability and use patterns specific to pregnant women and children. It is essential that any new

standard for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded throughout their lifetimes."

...

"The current metric of RF exposure available to consumers, the Specific Absorption Rate, is not an accurate predictor of actual exposure. AAP is supportive of FCC developing standards that provide consumers with the information they need to make informed choices ... ."

EXHIBIT 30E (FD):

Letter from U.S. Food and Drug Administration Jefferson Laboratories, National Center for Toxicological Research to National Toxicology Program, National Institute for Environmental Health Sciences, NIEHS, dated May 19, 1999.
https://ntp.niehs.nih.gov/ntp/htdocs/chem_background/.../wireless051999_508.pdf

Reads in part:

"[U]se of wireless communications devices (e.g., cellular phones) is increasing rapidly. **FDA concluded over five years ago that little was known about the possible health effects of repeated or long-term exposure to low levels of RFR of the types emitted by such devices**. However, **some scientific articles suggest a potential cancer risk may exist**." (Underlining and emphasis added.)

...

"**It is not scientifically possible to guarantee those non-thermal levels of microwave radiation ... will not cause long-term adverse health effects**." (Underlining and emphasis added.)

...

"Along with investigations carried out *in vitro*, a number of *in vivo* investigations have also been performed. Of particular interest is, for example, the study conducted by Szmigielski et al (1983), who observed faster development of benzo(a)pyrene-induced skin tumors in mice that were exposed for some months to sub-thermal 2450 MHz microwave radiation.

"Also of interest is a study where 100 rats were exposed from 2 to 27 months of age to pulsed microwave radiation (0.4 W kg-1) (Guy et al, 1985). The exposed group had a significant increase in primary malignant lesions compared with the control group when lesions were pooled regardless of their location in the body, but no single type of malignant tumor was enhanced. Overall the incidence of primary malignancies was similar to that reported elsewhere in rats of this type. If the incidence of primary malignant lesions was pooled without regard to site or cause of death, however, the exposed group had a significantly higher incidence compared with the control group. Also, primary malignancies occurred early in the exposed group compared with the sham exposed group."

EXHIBIT 42B-1 (FD):
BioInitiative 2012: A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation. The *BioInitiative 2012 Report* has been prepared by 29 authors from ten countries, ten holding medical degrees (MDs), 21 PhDs, and three MSc, MA or MPHs. Among the authors are three former presidents of the Bioelectromagnetics Society, and five full members of BEMS. http://www.bioinitiative.info/bioInitiativeReport2012.pdf

Section 4 of this document, entitled ***Evidence for Inadequacy of the Standards***, reads in part:

[Inadequacy of standards - Begin quote]

US Government Radiofrequency Interagency Working Group Guidelines Statement

The United States Radiofrequency Interagency Working Group (RFIAWG) cited concerns about current federal standards for public exposure to radiofrequency radiation in 1999 (Lotz, 1999 for the Radiofrequency Interagency Working Group)

"*Studies continue to be published describing biological responses to nonthermal ELF-modulated RF radiation exposures that are not produced by CW (unmodulated) radiation. These studies have resulted in concern that 'exposure guidelines based on thermal effects, and using information and concepts (time-averaged dosimetry, uncertainty factors) that mask any differences between intensity-modulated RF radiation exposure and CW exposure, do not directly address public exposures, and therefore may not adequately protect the public."* (Emphasis added.)

The United States government Federal Radiofrequency Interagency Working Group has reviewed the existing ANSI/IEEE RF thermal-based exposure standard upon which the FCC limit is based. **This Working Group was made up of representatives from the US government's National Institute for Occupational Safety and Health (NIOSH), the Federal Communications Commission (FCC), Occupational Health and Safety Administration (OSHA), the Environmental Protection Agency (US EPA), the National Telecommunication and Information Administration, and the US Food and Drug Administration (FDA)**. (Emphasis added.)

On June 17, 1999, the RFIAWG issued a Guidelines Statement that concluded the present RF standard "may not adequately protect the public". The RFIAWG identified fourteen (14) issues that they believe are needed in the planned revisions

of ANSI/IEEE RF exposure guidelines including **"**to provide a strong and credible rationale to support RF exposure guidelines". In particular, **the RFIAWG criticized the existing standards as not taking into account chronic, as opposed to acute exposures, modulated or pulsed radiation (digital or pulsed RF is proposed at this site), time-averaged measurements that may erase the unique characteristics of an intensity-modulated RF radiation that may be responsible for reported biologic effects, and stated the need for a comprehensive review of long-term, low-level exposure studies, neurological-behavioral effects and micronucleus assay studies (showing genetic damage from low-level RF)**. (Underlining and emphasis added.)

The existing federal standards may not be protective of public health in critical areas. The areas of improvement where changes are needed include: a) selection of an adverse effect level for chronic exposures not based on tissue heating and considering modulation effects; b) recognition of different safety criteria for acute and chronic exposures at nonthermal or low-intensity levels; c) recognition of deficiencies in using time-averaged measurements of RF that does not differentiate between intensity-modulated RF and continuous wave (CW) exposure, and *therefore may not adequately protect the public.*

[Inadequacy of standards - End quote]

3. Exhibits and Partial Transcripts of Official Testimonies and Testimonial Reports by Expert Medical Doctors and Research Scientists

This section includes the following:

Exhibit Nos. 1B, 1C, 1D, 1E, 1F, 1G, 1H, 1I, 1J-1, 1J-2, 4D-1, 4D-2, 9B, 13, 14, 20B, 21E, 21G, 21H, 21I, 29C-7, 29C-15, 34A, 45A, 45B, 45C, 45H, 45J, 45R-3, and 45R-4.

All of the exhibits listed within this section constitute directly relevant and highly credible evidence of absolutely and completely reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

Additionally, Exhibit Nos. 1B, 1C, 1D, 1E, 1F, 1G, 1H, 1I, 1J-1, 1J-2, 13, 45A, 45B, 45H, and 45J also constitute legally credible, competent, and substantial evidence in accordance with Pa.R.E. 804(b)(1).

Because Dr. Martin Blank, PhD, the declarant in Exhibits 1J-1, 1J-2, and 34A is deceased, his testimonies in these exhibits constitute and can be received as credible, competent and substantial evidence under the provisions of Pa.R.E. 804(a)(4).

Because Dr. Ronald B. Herberman, MD, a declarant in Exhibit 13 is deceased, his testimony in this exhibit constitutes and can be received as credible, competent and substantial evidence under the provisions of Pa.R.E. 804(a)(4).

Dr. David O. Carpenter, MD, a/the declarant in Exhibits 1I, 13, 29C-15, 45B, and 45H, was accepted as an expert witness in the federal Civil Action No. 4:15-CV-40116-TSH, "G ... v. the Fay School," 282 F.Supp.3d 381 (2017), involving allegations of adverse health effects of exposure to radiofrequency radiation.

EXHIBIT 1B (FD):
Expert Report of Andrew A. Marino given in prior litigation proceedings before the Pennsylvania Public Utility Commission.
https://andrewamarino.com/PDFs/testimony-AAM_Report.pdf

Andrew A. Marino, JD, PhD, Biophysics, Professor, Department of Neurology, Louisiana State University Health Sciences Center. This expert report by Dr. Marino, including two exhibits with long listings of his own and participatory research publications and resources, was submitted as part of a case before the Pennsylvania Public Utility Commission, with PECO Energy as respondent. Dr. Marino's report reads in part:

"Scientific evidence indicates that the neurological syndrome of electromagnetic hypersensitivity exists. There is a reasonable basis to believe that the symptomatology of the Complainants and its relation to smart-meter electromagnetic energy is factual. There is a basis in established science to support the Complainants' concerns that future exposure to smart-meter energy will worsen their already precarious medical conditions. Ample scientific evidence indicates that the aforementioned exposure would be a risk to the health of the Complainants." (p. 1.) ...

"There is a sound basis in experimental biology that supports their concerns regarding the consequences to their health that have occurred and that may occur due to future chronic exposure to the electromagnetic energy emitted by smart meters. Under the conditions pertinent to the conditions of this case, **coercing the Complainants to endure these risks and uncertainties is unwarranted, unjustified, and would amount to involuntary human experimentation by PECO.**" (p. 27.) (Emphasis added.) ...

In rebutting and repudiating Dr. Israel's prior testimony before the Pennsylvania Public Utility Commission, Dr. Marino states the following:

"Dr. Israel uses the term 'medical evaluation' equivocally. ...

"He sometimes employs 'medical evaluation' idiosyncratically to mean, judging from context, that he reads the scientific literature dealing with the experimental biology of electromagnetic fields, the epidemiological studies dealing with that topic, and the opinion of various agencies and blue-ribbon committees, and evaluates that literature using his skills as a physician, leading him to opine that the Complainants have not been injured by exposure to smart meters and even in the future they will not be injured by smart-meter energy. When Dr. Israel uses 'medical evaluation' in this sense, to mean the analysis of peer-reviewed scientific publications by a physician who has not actually done research on the subject in question I have a definite opinion, namely that it is ineffective and fruitless. Science and medicine each have rules for generating and recognizing knowledge, and the two systems are different. Confounding the two sets of rules, as he did, is unhelpful and unfortunate, and ultimately impossible. He clearly rejects the idea of electromagnetic hypersensitivity, but he didn't get to that conclusion by conducting an authoritative scientific analysis of the literature based on familiarity and experience in the area. ...

"I can say with considerable confidence it didn't come from scientific analysis. Then he rationalized his choice by cherry-picking published studies that fit his mindset, particularly the work of Rubin. Dr. Israel's reliance on Rubin was to me the clearest possible indication that he does not know the territory related to the health risks of electromagnetic energy." (pp. 36-38.) ...

"According to the FCC, smart meters and cellphones are safe when manufactured according to the presently mandated emission levels. But the FCC defines an emission level as 'safe' if it doesn't result in adverse biological effects caused by heating or cooking of the exposed subject. Nowhere does the FCC say that smart meters are safe with regard to physiological changes by physical processes other than heating or cooking. That claim is unsupportable and counter-scientific, and has not been made by the FCC. ... [T]he notion that the FCC says smart meters are safe with respect to all possible mechanisms ... is not the case." (p. 44.) ...

"There is a very large data base of empirical studies in experimental biology that ***demonstrates beyond reasonable doubt*** that biological effects can occur at levels of man-made electromagnetic energy actually present in the environment." (p. 46.) ...

"[W]ith what are called linear systems, by which I mean things that follow laws whereby if a little change does something, ... a change ten times as much will do ten time[s] more. Virtually every system in the world of an engineer works that way. But animals and human beings are nonlinear systems, by which I mean that their laws can allow things to happen which cannot happen in linear systems. For

example, human beings can exhibit very strong responses to very small stimuli in the complete absence of a proportion between the cause and the effect. Dr. Davis's assumption that the stimulus-response relationships of human beings are governed by linear laws is wrong. See Exhibit 2 at No. 84, 88, and 89. Consequently he has no rational basis to argue that PECO's [level of electromagnetic] energy [caused by smart meters] is too small to matter." (pp. 48-49.)

The conclusions stated in Dr. Marino's report are as follows:

"First, [there] is a reasonable basis in established science for the Complainants' concern regarding risks to human health caused by man-made electromagnetic energy in the environment, including the type of electromagnetic energy emitted by smart meters. These health risks are heightened in the very young, the very old, and in those with preexisting diseases or disorders.

"Second, electromagnetic hypersensitivity is a documented neurological condition in which the affected person experiences musculoskeletal, immunological, and/or neurological symptoms that noticeably flare or intensify upon exposure to man-made electromagnetic energy in the environment. About 5-10% of the general public are self-reported to suffer from this disorder.

"Third, the Complainants were forced into the almost impossible position of conducting experiment[s] on themselves to prove to PECO's satisfaction that their claims of a link between their symptoms and electromagnetic energy from smart meters were sufficiently credible as to warrant some remediable action by PECO.

"Fourth, there is no justifiable reason for PECO to doubt the reality of the Complainants' symptoms, to question their intentions in seeking relief, or to not respect and implement the advice they received from their physicians that exposure to smart-meter energy should be avoided.

"Fifth, ***chronic exposure to the electromagnetic energy from smart meters causes risks to human health that go far beyond the capability of the energy to trigger hypersensitivity reactions in sensitive persons. A large literature in experimental biology indicates that man-made electromagnetic energy, including that from smart meters, causes biological effects involving every essentially physiological process that occurs in living organisms. A large literature in nonexperimental biology shows that man-made electromagnetic energy, including that from smart meters, is associated with a plethora of human diseases.*** People who suffer from pre-existing conditions are particularly vulnerable, and all the Complainants suffer from such conditions.

"Sixth, PECO's claim that the FCC has pronounced smart meter[s] safe is spurious because the FCC has made that statement only with regard to the heating and

cooking effects of electromagnetic energy. The Complainants have made no claims that smart meters are like microwave ovens.

"Seventh, PECO has claimed that expert committees have pronounced smart meters safe, but PECO has not acknowledged the blatant conflicts-of interests that infect such committees nor the serious limitations on their reports, such as the *failure to address much of the relevant literature*.

"Eighth, PECO proposes to expose human beings to smart-meter electromagnetic energy over their objection under conditions that would not be acceptable to any institution in the United States where human experimentation can lawfully be performed. Consequently, coercing the Complainants to endure the risks and uncertainties of such exposure is unwarranted, unjustified, and would amount to involuntary human experimentation by PECO." (pp. 52-53.) (Underlining, italics and emphasis added.)

EXHIBIT 1C (FD):

Pre-filed Testimony of Dr. Lennart Hardell, MD, PhD, MPUC Docket No. 2011-00262. https://ecfsapi.fcc.gov/file/7520940944.pdf

Dr. Lennart Hardell, MD, PhD, Professor of Oncology and world expert on epidemiological study of RF radiation exposure effects in relation to cancer causation. Reference to Dr. Hardell's educational and professional background and experience appear on pp. 1-5. Dr. Hardell's curriculum vitae and prolific number of peer-reviewed research publications are listed beginning with 'Hardell Exhibit A' following his full testimony in the accompanying PDF file of this exhibit. Dr. Hardell's testimony pertains specifically to health risks of radiofrequency electromagnetic fields, including those produced by smart meters, and reads in part:

[Hardell testimony - Begin quote]

Q. Are you familiar with other peer-reviewed epidemiological studies addressing the risk of cancer, disease, or other adverse health effects resulting from the exposure to RF-EMF, meaning radio frequency radiation at levels below which thermal effects are known to occur?

A. Yes. Since this is one of my specialties I have studied and scrutinized most of the peer-reviewed studies that have been published on the subject since the 1990's. It has also been part of being a scientific expert, etc see above.

...

Q. Experts testifying for CMP, Drs. Bailey and Shkolnikov, emphasized the importance of a Danish cohort study on mobile phone users and cancer risks. Are you familiar with that study?

A. Yes.

Q. Are the results in the Danish cohort study reliable and based on sound epidemiological methods?

A. No. This was a record linkage study partly funded by two Danish telecom-operating companies, TeleDenmark Mobil and Sonofon, with no individual exposure data. It has produced four articles that we have made a thorough review of (Söderqvist et al 2012a). We concluded that its many limitations - embedded in the study design from the very beginning and mainly related to poor exposure assessment - cloud the findings of the four reports to such an extent that render them uninformative, at best. At worst, they may be used in a seemingly solid argument against an increased risk– and the reader may not understand that the Danish cohort study is a textbook example of a study design that precludes the possibility to find an increased risk, as we have discussed in our review. The term *business bias* may apply to the Danish cohort study, a terminology recently discussed by Levis et al (2012). There is always a potential of conflicts of interest when a study is sponsored by the industry (Hardell et al 2007b)

The Danish cohort study was included in the IARC evaluation of RF-EMF as human carcinogen, but the conclusion was that "phone provider, as a surrogate for mobile phone use, could have resulted in considerable misclassification in exposure assessment." (Baan et al 2011). Thus, the Danish cohort study was considered to be uninformative as to cancer risks from mobile phone use.

...

Q. Based on all of the epidemiological evidence available, please state your opinion about the extent of the association between exposure to RF-EMF and cancer.

A. There is a consistent pattern of an increased risk of glioma (malignant brain tumor) and acoustic neuroma (benign tumor on the 8th cranial nerve) associated with use of wireless phones (both mobile phones and cordless phones). The increased risk is highest for tumors on the same side of the head (ipsilateral) as the phone has been used during long- term and highest cumulative use in hours over the years. The conclusion is based on all studies, especially those that provide results for at least 10 years latency period (time from first use until tumor diagnosis) for use of wireless phones.

...

In summary the strengths of evidence areas follow, using the Hill criteria from 1965 (Hill 1965). For more details see also Carlberg, Hardell (2012) and Hardell et al (2011, 2012).

1. **Strength:** Ipsilateral use (tumor in the brain on same side as where wireless phone was used) finds the highest risk, especially for localisations with highest exposure (temporal lobe). Cumulative hours of use finds the highest risk

2. **Consistency**: Similar results have been found in different studies, e.g. the Hardell group and Interphone.

3. **Specificity:** Regions of brain which absorb the highest wireless phone radiation (e.g., temporal lobe) have the highest risk. Risk pattern differs according to brain tumor type.

4. **Temporality**: Those with most years since first use have the highest risk; i.e. an effect of latency time.

5. **Biological gradient:** There is a clear dose-response effect, i.e. higher cumulative use in hours of wireless phones gives a higher risk with statistically significant trend.

6. **Plausibility**: Laboratory studies show toxic effects from RF-EMF on DNA that may lead to an increased risk for brain tumors. These non-thermal effects are mediated via the formation of reactive oxygen species (ROS).

7. **Coherence:** Several studies show by now an increasing incidence of brain tumors, especially of the type that would be expected based on epidemiological results (glioblastoma multiforme), in the most exposed parts of the brain (temporal and adjacent lobes).

8. **Experiment:** In the Hardell group studies it was shown that the group of subjects that only used the mobile phone in a car with a fixed external antenna (no exposure) did not have an increased risk for brain tumors in contrast to users without such devices (Hardell et al 2002). The EMF-RF toxic effects on DNA mediated by ROS can be prevented by antioxidants.

Sir Austin Bradford Hill (1965) noted that: "However, before deducing 'causation' and taking action we shall not invariably have to sit around awaiting the results of that research. The whole chain may have to be unravelled or a few links may suffice. It will depend on circumstances." p 295. And "If we are wrong in deducing causation from associations no great harm will be done....All scientific work is incomplete...That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time." p 300.

Using the Hill criteria on use of wireless phones and brain tumor risk infers causation of the association found in epidemiological studies. Most of these criteria are fulfilled.

...

Q. In their testimony, Dr. Bailey and Dr. Shkolnikov cite a report by the ICNIRP Committee, which concluded, "the trend in the accumulated evidence is increasingly against the hypothesis that mobile phone use causes brain tumors." Do you agree with that conclusion?

A. No, this is not a statement based on up-to-date knowledge of the scientific literature; see above, e.g. regarding meta-analysis of the brain tumor risk. Furthermore, it should be noted that the International Agency for Research on Cancer (IARC) at WHO evaluation of the carcinogenic effect of RF-EMF on humans took place during a 24 – 31 May 2011 categorised the radiofrequency electromagnetic fields from mobile phones, and from other devices that emit similar non-ionising electromagnetic fields (RF-EMF), as Group 2B, i.e. a 'possible', human carcinogen (Baan et al 2011, IARC in press).

The IARC decision on mobile phones was based mainly on two sets of case-control human studies; the Hardell group of studies from Sweden and the IARC Interphone study. Both provided complementary and supportive results on positive associations between two types of brain tumors; glioma and acoustic neuroma, and exposure to RF-EMF from wireless phones. I was an invited expert and the results from our research group were included in the evaluation as foundation for classification of the carcinogenic potential to humans from RF-EMF exposure. The Danish cohort study on mobile phone 'users' was considered to be uninformative. Besides our studies only Interphone gave results for long-term use of mobile phones (also cordless phones in our study group). The other studies were judged to be uninformative as to long-term cancer risks.

Q. Dr. Bailey and Dr. Shkolnikov testified that: "Despite the substantial increase in mobile phone use since the mid-1990s, rates of brain cancer incidence have generally remained consistent over time." Do you agree with that conclusion?

A. No, see our discussion about brain tumor incidence in our recent article in Pathophysiology (Hardell et al 2012). **In fact several studies have shown increasing incidence of brain tumors.** (Emphasis added.)

In Denmark a statistically significant increase in incidence rate per year for brain and central nervous system tumors (combined) was seen during 2000-2009; in men +2.7 %, 95 % CI = +1.1 to 4.3 % and in women +2.9 %, 95 % CI = +0.7 to 5.2 % (NORDCAN). Furthermore, updated results for brain and central nervous system

tumors have been released in Denmark. The age-standardized incidence of brain and central nervous system tumors increased with 40 % among men and 29 % among women during 2001-2010 (Sundhedsstyrelsen, 2010). A more recent news release based on the Danish Cancer Register stated that during the last 10 years there has been an increasing number of cases with the most malignant glioma type, glioblastoma multiforme (astrocytoma WHO grade IV), especially among men (http://www.cancer.dk/Nyheder/nyhedsartikler /2012kv4/Kraftig+stigning+i+hjernesvulster.htm).

Zada et al (2012) studied incidence trends of primary malignant brain tumors in the Los Angeles area during 1992-2006. The overall incidence of primary malignant brain tumors decreased over the time period with the exception of glioblastoma multiforme (astrocytoma WHO grade IV). The annual age adjusted incidence rate of that tumor type increased statistically significant in the frontal lobe of the brain with Annual Percentage Change (APC) +2.4 % to +3.0% ($p \leq 0.001$) and temporal lobe APC +1.3 to +2.3 % ($p \leq 0.027$) across all registries. In the California Cancer Registry the incidence of glioblastoma multiforme increased also in cerebellum, APC +11.9 % ($p < 0.001$). That means that the incidence increased most in the parts of the brain with highestabsorption of RF-EMF emissions during use of wireless phones (Cardis et al 2008) andespecially for the tumor type, glioblastoma multiforme, with high risk from such emissions (Hardell et al 2012).

Of interest is also the report by de Vocht et al (2011) from England that showed for the time period 1998 to 2007 a statistically significant increasing incidence of brain tumors, the majority glioma, in the temporal lobe for men and women ($p < 0.01$), and frontal lobe for men ($p < 0.01$). That means an increasing risk for a tumor type in a specific area of the brain that would be predicted based on current knowledge on the risk pattern.

Deltour et al (2012) reported increasing glioma incidence rates in Denmark, Finland, Norway, and Sweden for the time period 1979-2008. APC increased for men with +0.4 %, 95 % CI +0.1 to 0.6 % and for women with +0.3 %, 95 % CI +0.1 to 0.5 %. A study from Australia for the time period 2000-2008 showed that APC for malignant brain tumors increased statistically significant +3.9 %, 95 % CI +2.4 to 5.4 % (Dobes et al 2011). An increase was seen among both men and women. The APC for benign tumors increased with +1.7 %, 95 % CI -1.4 to +4.9 %, thus not statistically significant.

From urban Shanghai an increasing incidence of brain and nervous system tumors for the time period 1983-2007 was reported with APC +1.2 %, 95 % CI +0.4 to 1.9 % in males and APC +2.8 %, 95 % CI +2.1 to 3.4 % in females (Ding and Wang 2011).

We reported increasing incidence of astrocytoma WHO grades I-IV during 1970-2007 in Sweden. In the age group > 19 years the annual change was +2.16 %, 95 % CI +0.25 to 4.10 % during 2000-2007, for further details see Hardell and Carlberg (2009).

In summary, it should be noted that studies on tumor type and anatomical localisation show an increasing incidence of brain tumors that would be expected based on increased risk from RF-EMF emissions. (Emphasis added.)

Q. Dr. Bailey and Dr. Shkolnikov discuss the IARC 2B classification. They emphasize a finding by the IARC that there is only "limited evidence" for cancer resulting from RF exposure. Can you explain what is meant by "limited evidence" in this context and its implications for assessing potential risks to humans from RF exposure?

A. A summary of the evaluation has been published by Baan et al in Lancet Oncology 2011 (Baan et al 2011) and the whole Monograph is to be published (IARC in press).

The conclusion at the IARC meeting was that RF-EMF is a 'possible' human carcinogen, Group 2B of evidence. There was a very large majority among the 30 participating independent experts for that decision; almost all voted for Group 2B in the summary evaluation. I was one of the 30 invited experts. The classification system can be found in the IARC Preamble.

(http://monographs.iarc.fr/ENG/Preamble/CurrentPreamble.pdf) .

IARC evaluates the **'hazard***'* of potential carcinogens, i.e. 'an agent that is capable of causing cancer under some circumstances', while a cancer **risk** is an estimate of the carcinogenic effects expected from an exposure to a cancer hazard. The IARC monographs are an exercise in evaluating cancer hazards, despite the historical presence of the words 'risks' in the title.

IARC has categorised nearly 1000 potentially carcinogenic **hazardous** agents, which it has studied over the past 40 years, into 5 classifications. These are differentiated by strengths of evidence.

In descending order of strengths of evidence they are:

- **Group 1**, which are '**established'** human carcinogens, such as asbestos, diesel engine exhaust, tobacco, and X-rays (109 agents);

- **Group 2A**, which are **'probable'** carcinogens, such as perchloroethylene (65 agents);
- **Group 2B,** which are **'possible'** carcinogens, such as other traffic fumes, lead, DDT and now radiofrequency electromagnetic fields including mobile phones (275 agents);
- **Group 3**, where the agent is '**not classifiable'** because the evidence is inadequate and does not permit another classification (503 agents); and
- **Group 4**, where the agent is **'probably not carcinogenic to humans'**, based on fairly strong evidence **against** a cancer effect in both humans and animals (1 agent).

Source: http://monographs.iarc.fr/ENG/Classification/index.php

It should be noted that most of the agents (n=503) were evaluated as 'not classifiable' Group 3 and one as 'probably not carcinogenic to humans', Group 4. Thus classification of RF-EMF as a carcinogen (possible) is based on scientific literature. It is not an agent that cannot be classified according to its potency to be a human carcinogen. This is an important distinction regarding the carcinogenic evidence of exposure to RF-EMF, i.e. belongs to the group of agents in Group 1 or 2 with carcinogenic potential.

More discussion can be found in our chapter in Late Lessons from Early Warnings, part 2, published by European Environment Agency, Copenhagen, Denmark (Hardell et al 2013).

...

Q. Does the IARC 2B classification of carcinogenicity apply to all sources of RF-EMF?

A. Yes. In an email by Dr Baan at IARC dated 29 Aug 2011 it was stated that: "So the classification 2B, possibly carcinogenic, holds for all types of radiation within the radiofrequency part of the electromagnetic spectrum, including the radiation emitted by base-station antennas, radio/TV towers, radar, Wi-Fi, smart meters, etc.", see Exhibit C. This is an important message; the IARC decision includes "the whole radiofrequency region of the electromagnetic spectrum." The frequency range 30 kHz – 300 GHz is also defined in the publication by Baan et al (2011).

Q. Dr. Bailey and Dr. Shkolnikov testified that: "a careful scientist cannot conclude that studies and reports have identified a true, non-thermal effect." Do you agree, assuming a definition of non-thermal effect as biological effects occurring below RF-EMF intensities at which thermal effects are known to occur?

A. There are by now a vast majority of scientific studies published in peer-reviewed scientific journals showing non-thermal effects. The brain tumor risk as discussed above is one non-thermal risk.

...

Another example of non-thermal effect is the finding that exposure to RF-EMF induces significant sperm DNA damage (Aitken et al 2005) and subsequent sperm apoptosis (De Iuliis et al 2009). Studies have shown a positive association between mobile phone use and impaired male reproduction (Agarwal et al 2009).

Specifically, the post-meiotic phase during DNA synthesis is the most vulnerable phase to environmental toxins, because during that phase the cells have lost part of their cytoplasm containing the abundant antioxidant enzymes that protect from reactive oxygen species (ROS) oxidation (Olsen et al 2005). Studies have shown that RF-EMF may stimulate ROS generation both in vivo (Avci et al 2012) and in vitro (Lu et al 2012). Increased generation of ROS is considered to be one of the primary mechanisms that are involved in the bio-effects that are mediated by RF-EMF exposure (Friedman et al 2007).

In a recently published study, it was demonstrated that RF-EMF exposure induced the formation of oxidative base damage in a mouse spermatocyte-derived cell line (Liu et al 2013). This was mediated by ROS production. These results suggest that RF-EMF radiation emitted during mobile phone use may produce genotoxicity in the form of DNA base damage, see Graphical Abstract with Legend, Dr Liu with courtesy, Exhibit D.

To further elucidate the central role of ROS in RF-EMF exposure-induced DNA base damage, the authors used α-tocopherol pre-treatment to antagonize the oxidation of ROS; α-tocopherol is an important lipophilic antioxidant that can inactivate harmful ROS. The protective role of α-tocopherol pre-treatment confirmed that ROS are involved in RF exposure-induced DNA base damage (Liu et al 2013). The mode of action for RF EMF-induced genotoxicity involved the induction of oxidative DNA base damage. These findings support the novel idea that low energy RF-EMF that is insufficient to directly induce DNA strand breaks may nonetheless produce genotoxic effects in the form of DNA base damage.

...

The results in the study by Liu et al (2013) and Shahin et al (2013) are important findings to further elucidate the mechanisms for RF-EMF genotoxicity. These effects are clearly non-thermal. In summary these and other studies show that oxidative stress is an important mechanism for adverse health effects from RF-EMF emissions.

Non-thermal effects of electromagnetic fields on living systems have been further discussed in a monograph from the Ramazzini Institute (Giuliani, Soffritti 2010).

http://www.icems.eu/papers/ramazzini_library5_part1.pdf;

Q. Is the blood-brain-barrier (BBB) a predictor of low-dose, or "non-thermal", adverse health effects?

A. Yes. In the BioInitiative Report 2012 leading researchers in this area, Dr Salford, Dr Nittby and Dr Persson conclude: "The intense use of mobile phones, not least by youngsters, is a serious memento. A neuronal damage may not have immediately demonstrable consequences, even if repeated. It may, however, in the long run, result in reduced brain reserve capacity that might be unveiled by other later neuronal disease or even the wear and tear of ageing. We cannot exclude that after some decades of (often), daily use, a whole generation of users, may suffer negative effects such as autoimmune and neuro-degenerative diseases maybe already in their middle age". (Salford et al 2012, page 45). They continue with:

"One remarkable observation, which we have made in our studies throughout the years, is that exposure with whole-body average power densities below 10 mW/kg gives rise to a more pronounced albumin leakage than higher power densities, all at non-thermal levels. These very low SAR-values, such as 1 mW/kg, exist at a distance of more than one meter away from the mobile phone antenna and at a distance of about 150–200 m from a base station.

Further, when a mobile phone operating at 915 MHz (and its antenna) is held 1.4 cm from the human head, the very low SAR levels of 10 mW/kg exist in deep-lying parts of the human brain such as the basal ganglia, and the power density of 1 mW/kg and less is absorbed in thalamus bilaterally.

With this information as a background, it is difficult to recommend safety limits as the function of existing mobile systems might not allow for limits that produce SAR levels below 1 or 0,1 mW/kg in the human brain, which are reported to cause a pathological leakage of the BBB and to neuronal damage." (Salford et al 2012, Page 45)

Thus, these very low RF-EMF levels giving neuronal damage (dark neurons) and BBB-leakage must be considered in the context of exposure from smart meters. Note the oxidative stress found in the Shahin et al (2013) study at power density 0.033549 mW/cm^2. [0.033549 mW/cm^2 equates to 33.549 μW/cm^2, that is, microwatts per square centimeter.] (Underlining and emphasis added.)

Q. Do you agree with their testimony that the authors of the Bioinitiative Report used flawed methods and failed to follow "the standard, scientific methods for developing exposure limits."

A. No. This is a statement that has no scientific credibility and is unfounded; see e.g. the BioInitiative Report 2012 (www.bioinitiative.org). In the Preface it is stated that:

"Today, the BioInitiative 2012 Report updates five years of science, public health, public policy and global response to the growing health issue of chronic exposure to electromagnetic fields and radiofrequency radiation in the daily life of billions of people around the world.

The BioInitiative 2012 Report has been prepared by 29 authors from ten countries, ten holding medical degrees (MDs), 21 PhDs, and three MsC, MA or MPHs. Among the authors are three former presidents of the Bioelectromagnetics Society [BEMS], and five full members of BEMS. One distinguished author is the Chair of the Russian National Committee on Non-Ionizing Radiation. Another is a Senior Advisor to the European Environmental Agency. As in 2007, each author is responsible for their own chapter.

The great strength of the BioInitiative Report (www.bioinitiative.org) is that it has been done independent of governments, existing bodies and industry professional societies that have clung to old standards. Precisely because of this, the BioInitiative Report presents a solid scientific and public health policy assessment that is evidence-based."
(http://www.bioinitiative.org/report/wp-content/uploads/pdfs/seci_2012_Preface.pdf)

It should be stressed that **the different chapters are written by world leading experts in the relevant scientific areas**. (Underlining and emphasis added.)

Q. Are there peer-reviewed studies reporting results that could support a plausible explanation for any mechanisms by which cancer could be caused by RF exposure?

A. Yes. ... DNA damages can be caused by cellular biochemical activities such as free radicals. Several studies indicate that RF-EMFs increase free radical activity in cells (Lai, Singh 1997, Phillips et al 2009).
...
Q. Should peak power densities or average power densities of RF-EMF be considered as to the health effects?

A. This is a question that has not been well studied. **First it must be emphasized that a carcinogenic hazard in general exists regardless of dose for epigenetic toxic effects, i.e. no threshold.** Dr Baan at IARC notes in a March 30, 2012 email that with lower dose "**the hazard still exists**". *See* Exhibit E. (Underlining and emphasis added.)

...

By analogy peak density of RF-EMF may more accurately represent the radiation exposure to the body than power density that is a calculated average dose during a specified time, i.e. **single peaks of radiation may have toxic effects and multiple peaks of radiation may have cumulative effects that are not accurately represented by averaged values.** Thus, peaks of density should not be recalculated as average dose over time when the risk is estimated, instead the peak density should also be considered. The peak density is of special concern regarding e.g. the foetus (pregnant women), children, adolescents, sick and disabled. (Underlining and emphasis added.)

Regarding ionizing radiation there is no homeostasis; that is that the body does not adapt to the exposure. The effects are permanent when a given part of the body is irradiated, the given radiation dose makes additional radiotherapy impossible (depending on dose) – otherwise more serious tissue damage would occur. **Regarding RF-EMF there are no well-done studies that show homeostasis in the human body for non-thermal effects. On the contrary studies show accumulating adverse health effects as exemplified by the brain tumor risk depending on cumulative dose over time (dose-response)**. Our results of decreased BTP concentration among long-term users of wireless phones (18-30 years of age) is another example of an cumulative effect and not homeostasis. **If the human body would adapt to the RF-EMF exposure no adverse health risks would occur, which is not the case.** (Underlining and emphasis added.)

Q. Dr. Bailey and Dr. Shkolnikov testified that: "The weight of the evidence does not support the idea that significant biological or adverse health effects can occur" from EMF-RF exposure. Do you agree with this conclusion?

A. No. On the contrary the weight of evidence shows an increased risk for certain types of brain tumors, see discussion above. The results are in accordance with what would biologically be plausible; see above the Hill (1965) criteria of evidence. On 23 January 2013 concern of adverse health effects by e.g. use of mobile phones were expressed at a meeting at the EU parliament in Brussels while Late Lessons from Early Warnings, Volume II was launched.

(http://www.eea.europa.eu/acl_users/credentials_cookie_auth/login_form?came_from=http%3A//www.eea.europa.eu/publications/late-lessons-2).

Furthermore, several studies show other non-thermal effects in humans that can be linked to certain outcomes like fertility and disturbed sleep as examples, see also the BioInitiative 2012 Report (www.bioinitiative.org).

Q. In your opinion, could a careful scientist familiar with the body of knowledge on the subject reliably conclude that there are no risks of adverse health effects from the exposure to RF in the 2.4 GHz range?

A. No. The body of evidence shows risk of impaired health from the RF-EMF exposure and 2.4 GHz is included in the IARC evaluation 30 kHz – 300 kHz. Hill's analytic framework for assessing when the association is strong enough to infer causation and warrant action has been discussed above. This is particularly relevant when the question is whether a person is exposed to an agent of possible harm, such as RF-EMF, in the home or in his/her own living environments without consent.

Sir Bradford Hill in his famous article on causation provides a helpful framework for assessing the risk and he offers some very insightful comments that are useful in this context (Hill 1965). **To answer those scientists who insist that every positive study be replicated, he states that**

"Once again looking at the obverse of the coin **there will be occasions when repetition is absent or impossible and yet we should not hesitate to draw conclusions**." Hill, p. 297.

To those who insist we wait until the exact causal mechanism is established, he states:

"**It will be helpful if the causation we suspect is biologically plausible. But this is a feature I am convinced we cannot demand.** What is biologically plausible depends upon the biological knowledge of the day." P. 298.

To those who insist on more in vivo or in vitro evidence, he states:

"Nevertheless, while such laboratory evidence can enormously strengthen the hypothesis and, indeed, may determine the actual causative agent, **the lack of such evidence cannot nullify the epidemiological observations in man**." P. 298

"**What I do not believe** - and this has been suggested - **is that we can usefully lay down some hard-and-fast rules of evidence that must be obeyed before we accept cause and effect**." P. 299 (Emphasis added.)

Q. What is the message from the European Environment Agency (EEA) in Copenhagen regarding emerging technologies such as wireless networks currently in use?

A. On 23 January 2013 EEA published their 'Late Lessons from Early Warnings, Volume II' at a public meeting in the EU parliament in Brussels. Among the Key recommendations are:

- Policy makers should respond to early warnings more rapidly, the report says, particularly in cases of large scale emerging technologies. It proposes that those causing any future harm should pay for the damage.

- Risk assessment can also be improved, the report says, by embracing uncertainty more broadly and acknowledging what is not known. For example, 'No evidence of harm' has often been misinterpreted to mean 'evidence of no harm' when the relevant research was not available.

- The report calls for new forms of governance involving citizens in choices about innovation pathways and risk analysis. This would help to reduce exposure to hazards and encourage innovations with broader societal benefits. Greater interaction between business, governments and citizens could foster more robust and diverse innovations at less cost to health and the environment (http://www.eea.europa.eu/pressroom/newsreleases/the-cost-of-ignoring-the) .

...

Q. Based on your own research and scientific knowledge what is your opinion about the risks associated with smart meters?

A. **There is accumulating evidence on the potential of exposure to RF-EMF to give adverse health consequences and these effects are clearly non-thermal at low intensity.** Certain groups of humans such as children, adolescents, elderly and the sick and disabled are more sensitive than others. The unborn child (foetus) may be at especially high risk. Exposure to RF-EMF from smart meters is without consent in contrast to use of wireless phones that are used by the individual's own choice. I have not performed a detailed study of smart meter technology, and **ultimately this is more of a policy question than a scientific one. But, in my opinion, using the Hill criteria on association or causation, there is sufficient evidence to warrant actions that would prevent or avoid exposure, and the utility should be required to prove that smart meter radiation is safe without relying on safety standards that protect only against thermal effects**. (Underlining and emphasis added.)

[Hardell testimony - End quote]

EXHIBIT 1D (FD):
Pre-filed Testimony of Dr. Jerry L. Phillips, MPUC Docket No. 2011-00262. https://ecfsapi.fcc.gov/file/7520940948.pdf

Dr. Jerry L. Phillips, PhD, Biochemistry, Research Scientist, Director of the Center of Excellence in Science, and Professor, University of Colorado. Dr. Phillips is a leading expert in the use of comet assay techniques in the study of DNA damage effects associated with RF radiation exposure. Reference to Dr. Phillips' educational and professional background and experience appear on pp. 1-2. Dr. Phillips' curriculum vitae and prolific number of peer-reviewed research publications are listed beginning with 'Phillips Exhibit A' following his full testimony in the pdf file (FD). Dr. Phillips' testimony pertains specifically to assessment of evidence and research of biological effects of RF radiation. His testimony also contains a clear and insightful assessment of the use and misuse of the phrase, **"weight of evidence."** Reads in part:

[Phillips testimony - Begin quote]

Q. Briefly describe your work and experience related to the study of electromagnetic fields and radio frequency waves in the 30 MHz to 300 GHz range ("RF"), and about their potential effects on biological systems.

A. I began studying the biological effects of 60Hz electric and magnetic fields in about 1983 at the University of Texas San Antonio and at the University of Texas Health Sciences Center at San Antonio and the Cancer Therapy and Research Center. My laboratory's focus was on the effects of extremely low frequency (ELF) electromagnetic fields (EMFs) on cancer cell proliferation ("growth") and survival characteristics. After moving to the Pettis Memorial VA Center in Lorna Linda, CA, my laboratory continued the ELF EMF work and began work with funding from Motorola Corporation on the biological effects of RF radiation (RFR) at cell telephone frequencies. We studied several endpoints, including RFR effects on gene expression, DNA damage and repair, and central nervous system tumor development. At the University of Colorado Colorado Springs, I maintain an active interest in the biological effects of non-ionizing radiation. Additionally, at the request of editors of several peer-reviewed publications, I review 3-6 manuscripts/year that have been submitted to those journals.

Q. Are you familiar with other research studies and writings on the subject?

A. Yes, I am reasonably familiar with a wide range of literature over the last 40 years that describes biological effects (or not) as a result of ELF EMF and RFR exposure.

Q. Are you familiar with peer-reviewed research studies, *in vivo* and /or *in vitro,* that reported positive results showing non-thermal biological effects after exposure to low-level RF, meaning below the level at which "thermal" effects have been confirmed?

A. Yes, I am familiar with many peer-reviewed research studies reporting positive results of non-thermal biological effects from exposure to low-level RF.

Q. Please list some of the types of biological effects for which the studies have reported positive results.

A. The reported biological effects include a wide range of changes, including those associated with cells in a dish *(in vitro* studies), laboratory animals *(in vivo* studies), and humans ("clinical" studies and epidemiologic studies). Those associated with cells include DNA damage and other genotoxic effects, increased permeability of blood-brain barrier, changes in calcium ion efflux, changes in gene expression and protein expression.

Q. Did some studies involve exposure to RF in or near the 2.4 GHz range?

A. Yes. A number of studies involving exposure to RF in that range have shown positive results for non-thermal biological effects.

Q. Are there possible explanations for the mechanisms by which non-thermal biological effects reported in the literature could be caused by RF exposure?

A. Yes, a number of studies and reports have described possible mechanisms to explain the physiological or biochemical mechanisms by which the observed effects could occur. One possibility is that DNA is damaged by free radicals that are formed inside cells. Free radicals affect cells by damaging macromolecules, such as DNA, protein, and membrane lipids. Several reports have indicated that EMF enhances free radical activity in cells, particularly via the Fenton reaction:

H. Lai, N.P. Singh, Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells, Bioelectromagnetics 18 (1997) 446-454;

H. Lai, N.P. Singh, Effects of microwaves and a temporally incoherent magnetic field on single and double DNA strand breaks in rat brain cells, Electromag. Bioi. Med. 24 (2005) 23-29;

H. Lai, N.P. Singh, Melatonin, N-tert-butyl-alpha-phenylnitrone block 60-Hz magnetic field-induced DNA single and double strand breaks in rat brain cells, J. Pineal. Res. 22 (1997) 152-162;

H. Lai, N.P. Singh, Magnetic-field-induced DNA strand breaks in brain cells of the rat, Environ. Health Perspect. 112 (2004) 687-694;

B. Oral, M. Guney, F. Ozguner, N. Karahan, T. Mungan, S. Comlekci, G. Cesur, Endometrial apoptosis induced by a 900-MHz mobile phone: preventive effects of vitamins E and C, Adv. Ther. 23 (2006) 957-973;

M. Simko, Cell type specific redox status is responsible for diverse electromagnetic field effects, Curr. Med. Chem. 14 (2007) 1141-1152.

Additionally, the work of Blank and Soo and Blank and Goodman support the possibility that EMF exposure at low levels has a direct effect on electron transfer processes:

M. Blank, L. Soo, Electromagnetic acceleration of the Belousov-Zhabotinski reaction, Bioelectrochemistry 61 (2003) 93-97.

M. Blank, R. Goodman, A mechanism for stimulation of biosynthesis by electromagnetic fields: charge transfer in DNA and base pair separation, J. Cell. Physiol. 214 (2008) 20-26.

Although the authors do not discuss their work in the context of EMF-induced DNA damage, the possibility exists that EMF exposure could produce oxidative damage to DNA. Other possible mechanisms include RFR-induced changes in gene expression, in stress-protein expression, in permeability of the blood-brain barrier, and in the level or movement of key cellular ions, such as calcium.

Q. Are you familiar with any peer-reviewed epidemiological studies reporting positive results for a risk of cancer, disease, or other adverse health effects resulting from the exposure to RF?

A. Yes.

Q. Are there possible explanations for the mechanisms by which cancer and other diseases could be causally related to the non-thermal biological effects of RF exposure?

A. Yes. Some of the observed biological effects, including DNA damage and other genotoxic effects, could possibly have carcinogenic effects resulting from repeated exposures over time. It is interesting that ELF EMF, in addition to RFR, has also

been shown to cause DNA damage. Furthermore, free radicals have been implicated in this effect of ELF EMF. This further supports the view that EMF affects DNA via an indirect secondary process, since the energy content of ELF EMF is much lower than that of RFR. Effects via the Fenton reaction predict how a cell would respond to EMF. For instance:

...

(1) Cells that are metabolically active would be more susceptible to EMF, because more hydrogen peroxide is generated by mitochondria to fuel the reaction.

...

(3) Since the brain is exposed to rather high levels of EMF during cell phone use, the consequences of EMF-induced genetic damage in brain cells are of particular importance. Brain cells have high levels of iron. Special molecular pumps are present on nerve cell nuclear membranes to pump iron into the nucleus. Iron atoms have been found to intercalate within DNA molecules. In addition, nerve cells have a low capacity for DNA repair, and DNA breaks could easily accumulate. Another concern is the presence of superparamagnetic iron-particles (magnetites) in body tissues, particularly in the brain. These particles could enhance free radical activity in cells and thus increase the cellular-damaging effects of EMF. These factors make nerve cells more vulnerable to EMF. Thus, the effect of EMF on DNA could conceivably be more significant on nerve cells than on other cell types of the body. Since nerve cells do not divide and are not likely to become cancerous, the more likely consequences of DNA damage in nerve cells include changes in cellular functions and in cell death, which could either lead to or accelerate the development of neurodegenerative diseases. Double-strand breaks, if not properly repaired, are known to lead to cell death. Cumulative DNA damage in nerve cells of the brain has been associated with neurodegenerative diseases, such as Alzheimer's, Huntington's, and Parkinson's diseases. However, another type of brain cell, the glial cell, can become cancerous as a result of DNA damage.

Other observed effects, including increased permeability of blood-brain barrier and changes in gene expression and protein expression, could possibly contribute to other disease conditions over time. Examples studies of these results are (this list is not intended to be all-inclusive):

B.R.R. Persson, Salford, L. G., Brun, A. BBB permeability in rats exposed to electromagnetic fields used m wireless communication. Wireless Networks:455-461 (1997).

L.G. Salford, A. Brun, J.L. Eberhardt, and B.R.R. Persson. Permeability of the blood-brain-barrier induced by 915 MHz electromagnetic-radiation, continuous wave and modulated at 8, 16, 50 and 200Hz. Bioelectrochemistry and Bioenergetics. 30:293-301 (1993).

L.G. Salford, A. Brun, K. Sturesson, J.L. Eberhardt, and B.R. Persson. Permeability of the blood-brain barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50, and 200 Hz. Microscopy research and technique. 27:535-542 (1994).

Schirmacher, A et al, 2000. Electromagnetic fields (1.8 GHz) increase the permeability of sucrose of the blood-brain barrier m vitro. Bioelectromagnetics 21:338-345.

Ivaschuk, OI et al, 1997. Exposure of nerve growth factor-treated PC 12 rat pheochromocytoma cells to a modulated radiofrequency field at 836.55 MHz: effects on c-jun and c-fos expression. Bioelectromagnetics 18 (3): 223-229.

Kwee, S et al, 200 1. Changes in cellular protiens due to environmental non-ionizing radiation. I. Heat-shock protiens. Electro-and Magnetobiology 20:141-152.

Leszczynski, D et al, 2002. Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in the human endothelial cells: Molecular mechanism for cancer- and blood-brain barrier-related effects. Differentiation 70: 120-129.

Leszczynski, D et al, 2004. Proteomics analysis of human endothelial cell line EA.hy926 after exposure to GSM 900 radiation. Short Communication. Proteomics 4, 1359-1365.

...

Q. Do the inconsistencies and negative result studies prove that the studies showing positive results are unreliable or wrong?

A. **No, nor do the studies showing negative results negate or cancel similarly done studies that demonstrate positive results. The positive results reported in well designed, peer-reviewed studies stand on their own merit as evidence of non-thermal biological effects, and the extensive number and quality of these studies as a whole stand as substantial evidence that such effects can occur from RF exposure.** That many of the studies on both sides of this issue have been done well is encouraging from a scientific perspective. **RFR exposure does indeed appear to produce a variety of biological effects**, and the total body of available data contains clues as to conditions producing effects and methodologies to detect them. **This view is in contrast to that of those who believe that studies unable to replicate the work of others are more credible than the original studies, that studies showing no effects cancel studies showing an effect, or that studies showing effects are not credible simply because we do not understand how those effects might occur**. (Emphasis added.)

Some may be tempted to apply incorrectly the teachings of Sir Karl Popper, one of the great science philosophers of the 20th century. Popper proposed that many examples may lend support to an hypothesis, while only one negative instance is required to refute it. While this holds most strongly for logical subjects, such as mathematics, it does not hold well for more complex biological phenomena that are influenced by stochastic factors. Each study to investigate RFR-induced biological changes must be evaluated on its own merits, and then studies that both show effects and do not show effects must be carefully evaluated to define the relationship of experimental variables to experimental outcomes and to assess the value of experimental methodologies to detect and measure these outcomes.

The negative results and inconsistencies among similarly done studies, so-called replication studies, or studies of similar endpoints (e.g., various types of DNA damage, or changes in the expression of various genes) may very well be explained by various factors or causes. For instance, differences in methodology can and often do produce distinctly different results. As an example, the use of an enzyme called proteinase K greatly enhances the sensitivity of the "comet assay," a technique used to detect damage to DNA. While some of us who have studied RFR-induced DNA damage have used proteinase K in our work, others who claim attempts to replicate our studies did not. Other methodological differences also contribute to lack of reproducibility.

There is a final point to be made about "consistency" of results. My own work [J.L. Phillips, 0. Ivaschuk, T. Ishida-Jones, R.A. Jones, M. Campbell-Beachler, W. Haggren, DNA damage in Molt-4 T- lymphoblastoid cells exposed to cellular telephone radiofrequency fields *in vitro,* Bioelectrochem. Bioenerg. 45 (1998) 103-110] was criticized by Gos and colleagues [P. Gos, B. Eicher, J. Kohli,W.D. Heyer, No mutagenic or recombinogenic effects of mobile phone fields at 900MHz detected in the yeast *saccharomyces cerevisiae*, Bioelectromagnetics 21 (2000) 515-523], who state: "The results in the latter study (Phillips et al., 1998) are puzzling and difficult to interpret, as no consistent increase or decrease in signal in the comet assay at various SARs or times of exposure was identified." What has been perceived as an inconsistent effect is indeed consistent with the observations of bimodal effects reported in hundreds of peer-reviewed publications. These bimodal effects may be dependent on concentration of an agent, time of incubation with an agent, or some other parameter relating to the state of the system under investigation.

Numerous examples from the literature point out that what appears to be inconsistency may instead be real events related to and determined by the agents involved and the state of the biological system under investigation. Our own results may be the result of signal modulation, signal intensity, time of exposure, or state

of the cells. The results may indicate a bimodal effect, or they may, as we suggested, represent time- and signal-dependent changes in the balance between damage and repair because of direct or indirect effects of RFR exposure on repair mechanisms.

Q. Have you reviewed the joint testimony of William H. Bailey, Ph.D. and Yakov Shkolnikov, Ph.D., dated September 19, 2012?

A. Yes.

Q. Dr. Bailey and Dr. Shkolnikov cite a 2012 review by AGNIR stating that "the evidence for a direct or indirect genotoxic effect is unconvincing." Do you agree with this conclusion?

A. No. Drs. Bailey and Shkolnikov seem to base their opinion on their version of "weight of evidence"-numbers of studies showing or not showing effects, not on the strength of specific studies. **There are well-done studies from several laboratories, including mine and Dr. Henry Lai's, in which changes in DNA damage are incontrovertible**. (Underlining and emphasis added.)

Phillips, J et al., 1998. DNA damage in molt-4 lymphoblastoid cells exposed to cellular telephone radiofrequency fields in vitro. Bioelectrochemistry and Bioenergetics 45:103-110.

De Iuliis GN, Newey RJ, King BV, Aitken RJ. 2009. Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. PLoS One 4(7):e6446.

Huang TQ, Lee MS, Oh E, Zhang BT, Seo JS, Park WY, (2008a) Molecular responses of Jurkat T-cells to 1763 MHz radiofrequency radiation. *Int J Radiat Biol.*, 84(9):734-741.

Lai H, Singh NP, Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells. *Bioelectromagnetics* 16(3):207-210, 1995.

Lai H, Singh NP, Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation. *Int J Radiat* Bio/69(4):513-521, 1996.

Lai, H, Singh, NP, Melatonin and a spin-trap compound block radiofrequency electromagnetic radiation-induced DNA strand breaks in rat brain cells. *Bioelectromagnetics* 18(6):446-454, 1997a.

Lai H, Singh NP. Melatonin and N-tert-butyl-alpha-phenylnitrone block 60-Hz magnetic field-induced DNA single and double strand breaks in rat brain cells. *J Pineal Res.* 22(3):152-162, 1997b.

Lai H, Carino MA, Singh NP, Naltrexone blocks RFR-induced DNA double strand breaks in rat brain cells. *Wireless Networks* 3:471-476, 1997.

Lai H, Singh NP Magnetic-field-induced DNA strand breaks in brain cells of the rat. *Environ Health Perspect.* 112(6):687-694, 2004.

Lai H, Singh NP, Interaction of microwaves and a temporally incoherent magnetic field on single and double DNA strand breaks in rat brain cells. *Electromag Bioi Med* 24:23-29, 2005.

Q. Dr. Bailey and Dr. Shkolnikov cite a report by the ICNIRP Committee, which concluded that "the trend in the accumulated evidence is increasingly against the hypothesis that mobile phone use causes brain tumors." Do you agree with that conclusion?

A. No. Drs. Bailey and Shkolnikov once again seem to base their opinion on their version of "weight of evidence," or perhaps on epidemiological studies that are flawed. **There are sufficient studies (some mentioned above) that identify the means by which RFR exposure could cause an increase in disease, including cancer, that identify an increase in disease in animals, and that identify an increased incidence of disease, including cancer, in humans.** The IARC saw fit to classify RFR exposure as a Group 2B carcinogen (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. (Underlining and emphasis added.)

Q. Do you agree with their testimony that "The weight of the evidence does not support the idea that significant biological or adverse health effects can occur" from exposure to RF?

A. Because the issue of RFR-induced bioeffects is contentious, and because the issue is tried in courtrooms and various public forums, a term heard frequently is

weight of evidence. This term generally is used to describe a method by which all scientific evidence related to a causal hypothesis is considered and evaluated. This process is used extensively in matters of regulation, policy, and the law, and it provides a means of weighing results across different modalities of evidence. When considering the effects of RFR exposure on DNA damage and repair, modalities of evidence include studies of cells and tissues from laboratory animals exposed in vivo to RFR, studies of cells from humans exposed to RFR in vivo, and studies of cells exposed in vitro to RFR. While weight of evidence is gaining favor with regulators, its application by scientists to decide matters of science is often of questionable value. One of the reasons for this is that there generally is no discussion or characterization of what weight of evidence actually means in the context in which it is used. Additionally, the distinction between weight of evidence and strength of evidence often is lacking or not defined, and differences in methodologies between investigators are not considered.

Consequently, weight of evidence generally amounts to what Krimsky [S. Krimsky, The weight of scientific evidence in policy and law, Am. J. Public Health 95 (2005) S129-S136.] refers to as a "seat-of-the-pants qualitative assessment." Krimsky points out that according to this view, weight of evidence is "a vague term that scientists use when they apply implicit, qualitative, and/or subjective criteria to evaluate a body of evidence." As examples, such is the case in the reviews by Juutilainen and Lang [J. Juutilainen, S. Lang, Genotoxic, carcinogenic, and teratogenic effects of electromagnetic fields, Introduction and overview, Mutat. Res 387 (1997) 165-171.] and Verschaeve and Maes [L.Verschaeve,A. Maes, Genetic, carcinogenic and teratogenic effects of radiofrequency fields, Mutat. Res. 410 (1998) 141-165.]. **There is little emphasis on a critical analysis of similarities and differences in biological systems used, exposure regimens, data produced, and investigator's interpretations and conclusions. Rather, there is greater emphasis on the number of publications either finding or not finding an effect of RFR exposure on some endpoint**. To some investigators, weight of evidence does indeed refer to the balance (or imbalance) between the number of studies producing apparently opposing results, without regard to critical experimental variables. While understanding the role these variables play in determining experimental outcome could provide remarkable insights into defining mechanisms by which RFR produced biological effects, few seem interested in or willing to delve deeply into the science. (Emphasis added.)

Given the lack of rigor in adequately evaluating the strengths and weaknesses of studies, the issue of weight of evidence is moot. What is more relevant is the existence of well-done studies that both show and don't show biological effects that result from RFR exposure, and the existence of epidemiological studies that show changes in disease incidence associated with RFR exposure. Together these well done studies provide a link between RFR exposure, the

incidence of disease in humans, and possible mechanisms by which disease incidence changes. (Emphasis added.)

Q. Do you agree with the testimony of CMP's experts that "a careful scientist cannot conclude that studies and reports have identified a true, non-thermal effect."?

A. No. I do not agree with this opinion. I, and many other very careful scientists, have concluded that an extensive number of studies and reports have identified a number of non-thermal biological effects resulting from low-level RF exposure. (Underlining and emphasis added.)

Q. In your opinion, could a careful scientist familiar with the body of knowledge on the subject reliably conclude that there is no evidence of, and no risk of, non-thermal effects from exposure to RF in the range of 1-3 GHz?

A. No.

Q. In your opinion, could a careful scientist familiar with the body of knowledge on the subject reliably conclude that there are no risks of adverse health effects from the exposure to RF in the 1-3 GHz range?

A. No.

[Phillips testimony - End quote]

EXHIBIT 1E (FD):
Pre-filed Testimony of Dr. Dariusz Leszczynski, MPUC Docket No. 2011-00262. https://ecfsapi.fcc.gov/file/7520940946.pdf

Dr. Dariusz Leszczynski, DSc, PhD, Molecular and Cell Biology, Research Professor of Radiation Biology, Radiation and Nuclear Safety Authority, Helsinki, Finland. Dr. Leszczynski is a leading expert on radiation biology and was a member of the Working Group of the IARC/WHO that in May 2011 classified cell phone radiation as a possible carcinogen. Reference to Dr. Leszczynski's educational and professional background and experience appear on pp. 1-2. Dr. Leszczynski's curriculum vitae and prolific number of peer-reviewed research publications are listed beginning with 'Leszczynski Exhibit A' following his full testimony in the pdf file (FD). Dr. Leszczynski's testimony pertains specifically to biological and health effects of exposure to RF radiation from use of cell phones. His testimony also provides commentary on the IARC classification of RF and an

insightful assessment of the meaning of the phrase, **"weight of evidence."** Reads in part:

[Leszczynski testimony - Begin quote]

Q. Briefly describe your professional work and experience related to the study of health risks related to electromagnetic fields and radio frequency waves in the 30 MHz to 300 GHz range ("RF").

A. I and my research group have worked in the field of biological and health effects of mobile phone radiation for the past 15years. We have studied the biological and health effects of mobile phone radiation using high-throughput screening techniques (HTST) of proteomics to identify the radiation-affected proteins and genes. We identified cellular signaling pathway that is activated by mobile phone radiation in human cells.

...

Q. Did you participate in the IARC Working Group classified low-level RF exposure as a possible carcinogen?

A. Yes, I was one of 30 scientists from 14 countries, who met at the International Agency for Research on Cancer (IARC) in Lyon, France, to assess the carcinogenicity of radiofrequency electromagnetic fields (RF-EMF) (list of experts in: Baan et al. Carcinogenicity of radiofrequency electromagnetic fields, Lancet Oncology 2011, 12: 624-626). The Working Group reviewed epidemiological evidence from cohort, case control, and time-trend studies, and also reviewed more than 40 studies assessing the carcinogenicity of RF-EMF in rodents, with exposures that simulated emissions from mobile phones.

...

Q. Did some of the Working Group members disagree with the conclusion that RF-EMF is a possible cause of cancer?

A. A very few members concluded that the evidence of carcinogenicity in humans was "inadequate". Their opinion focused on some inconsistency in the studies, the lack of evidence of any increase in incidence rates for glioma to parallel the increase use of mobile phone, and the Danish Cohort study which showed no increase in rates of glioma or acoustic neuroma. These concerns are not convincing. **The Danish study has several serious design flaws, and the time-trend analyses of cancer incidence rates are unreliable indicators because of long latency time of brain cancer.** (Emphasis added.)

Although time-trend analyses did not show an increased rate of brain tumors during a period of increased use of mobile phones, **most of the analyses examined trends only until the early 2000s. Such analyses are not informative of risks that**

manifest only after a decade or more of exposure, or of risks that may only affect a small proportion of cases involving heavy use and exposure. (Emphasis added.)

The following summarizes some of the flaws in the Danish study (pdf of the published in BMJ Letter to Editor attached):

1. Exposure data was unreliable. The only information about the person's exposure to mobile phone radiation is the length of the mobile phone subscription with the mobile phone operator. A person who spends many hours per week on the phone and one who spends just a few minutes per week could be analyzed as belonging to the same exposure group if they owned a mobile phone subscription for the same length of time. The highly exposed persons and the nearly unexposed persons are mixed up in the same exposure group. Analysis of such data cannot provide valid information about correlation of the exposure to mobile phone radiation and induction of brain cancer.

2. Composition of the control group. All corporate subscribers (200,507 subscribers) were excluded from the starting cohort of 723,421 mobile phone subscribers. Therefore, the people who most likely were the heaviest users and were the most exposed to mobile phone radiation were excluded from the study. Besides this, the exclusion of the corporate subscribers has likely led to "contamination" of the control group. As the authors state in the discussion section: "Because we excluded corporate subscriptions, mobile phone users who do not have a subscription in their own name will have been misclassified as unexposed ... ". This means that some of the possibly highly exposed corporate users, who did not have personal phone subscriptions, ended up as "nonexposed" persons in the control group.

Also the cut-off time of the exposure to mobile phone radiation was set for year 1995, but the analysis of the cancer induction was done based on 2007 cancer registry data. Any person who got a subscription after 1995 was considered as non-exposed by the set-up of the study. It means that for example a person diagnosed in 2007 with brain cancer, who subscribed after 1996 was, by the design of the study, considered as a non-exposed person who got brain cancer. Whereas, in reality, this person got brain cancer after being exposed for 11 years. Finally, even though the study started with over 723,421 mobile phone subscribers, and after some exclusions used 358,043 subscribers, the statistical evaluations presented by the study authors in tables 1, 2 and 3 in the article are largely based on just a few, or few tens, of cases. This means that the statistical results are unreliable because of low numbers.

Q. What is your opinion about the implications of the IARC classification of RF-EMF as a possible carcinogen?

A. **IARC classification supports three important conclusions:**

1. That "non-thermal" biological effects are induced by the RF-EMF that might, in due time, lead to health risks.

2. That current safety standards are insufficiently supported by the scientific evidence when they claim to reliably protect all users of mobile phones or other devices emitting mobile phone-like radiation.

3. That precautionary actions should be taken to protect people exposed to low-level RF-EMF and, whenever possible and feasible, to avoid exposure. (Emphasis added.)

ICNIRP and other standard setting agencies and organizations acknowledge the existence of only thermal effects of cell phone radiation. **ICNIRP's opinion is that the non-thermal effects are not proven and that they are unlikely to exist. However, the IARC classification contradicts this opinion and indicates that non-thermal effects do exist.** The results showing increased brain cancer risks in the INTERPHONE study and the Hardell studies were obtained from people using regular cell phones that emit low-level RF-EMF (below the levels at which thermal effects are confirmed) and that meet current safety standards. In spite of meeting current safety standards, long-term use of these cell phones led to increased risk of cancer. It logically means that low-level exposures may cause health risks and that the current safety standards may be insufficient. (Underlining and emphasis added.)

When potentially dangerous effects have been identified as deriving from a phenomenon, product or process, and the scientific evidence does not allow the risk to be determined with sufficient certainty, there is good cause to take action to prevent or avoid the risk. This is the essence of the Precautionary Principle recommended by the European Union. It is also consistent with Sir Bradford Hill's analysis using his nine factors to assess when an association between a risk and a potential cause is strong enough to justify protective action. Bradford-Hill A, The environment and disease: Association or causation? Proc R Soc Med 1965, 58:295-300. IARC evaluated all available scientific evidence on cancer and identified a potentially dangerous product (cell phone radiation and RF/EMF) but the scientific evaluation does not allow the risk to be determined with certainty. The response to this uncertainty should be further research
and the prevention and avoidance of risk until the uncertainty is resolved or perhaps until the proponents of the potentially dangerous product provide sufficient evidence of its safety.

...

Q. In April, 2012, almost a year after the IARC Working Group issued its conclusions on the carcinogenicity of RF/EMF, the UK Health Protection Agency's Advisory Group on Non-ionising Radiation (AGNIR) issued its latest report, *Health Effects from Radiofrequency Electromagnetic Fields.* Do you agree with the conclusions of this report?

A. The report was released with lots of media attention, especially in UK. It is a lengthy report, totaling some 333 pages, that claims to be an exhaustive review of all of the science on the issue. Reading it, however, is a surreal experience. **The authors either do not understand the studies they reviewed or they had pre-written conclusions.** (Emphasis added.)

I disagree with much of the science and the interpretation of study results in this report. However, **there is something even more disturbing about this report.** The report claims to be an exhaustive review of the science, **but it makes no mention of the 2011 IARC classification of cell phone radiation as a possible carcinogen, as if 1ARC's evaluation never took place.** It is obvious that the AGNIR's members do not agree with the outcome of the IARC evaluation. However, the complete omission of it is like rewriting history by omitting inconvenient facts. In my opinion it shows a very biased attitude of AGNIR members towards the IARC classification. **In cancer research the IARC evaluations are a "gold standard"**. (Emphasis added.)

The IARC classification is not the only thing missing from the report. The report claims to be the most comprehensive to-date review of all relevant studies published after 2003 (year of the first AGNIR Report). During the years 2004-2010 my research group at STUK published/co-authored 7 original studies on stress response, protein expression and gene expression executed both in cells grown in laboratory and in human volunteers. These studies are well known, very relevant, and were published in such well known journals as PROTEOMICS and BMC Genomics. Anyone can find them on PubMed. Not one of these studies performed by my research group is mentioned in the AGNIR Report. I can understand that one or two studies might be mistakenly forgotten when handling hundreds of studies. But seven separate studies? It is an intentional omission to skew the review and to mislead readers. No other explanation is plausible.

I looked for some studies by other scientists that were published after 2003.

List of the missing studies from my research group:

1. Nylund et al. Analysis of proteome response to the mobile phone radiation in two types of human primary endothelial cells. Proteome Science 2010, 8:52.

2. Nylund et al. Proteomic analysis of the response of human endothelial cell line EA.hy926 to 1800 GSM mobile phone radiation. J. Proteomics & Bioinformatics 2, 2009, 455-462.

3. Karinen et al. Mobile phone radiation might alter protein expression in human skin. BMC Genomics 9, 2008,77-.

4. Nylund & Leszczynski. Mobile phone radiation causes changes in gene and protein expression in human endothelial cell lines and the response seems to be genome- and proteome-dependent. Proteomics 6, 2006, 4769-4780.

5. Remondini et al. Gene expression changes in human cells after exposure to mobile phone microwaves. Proteomics 6, 2006, 4745-4754.

6. Nylund & Leszczynski. Proteomics analysis of human endothelial cell line EA.hy926 after exposure to GSM 900 radiation. Proteomics, 4, 2004, 1359-1365.

7. Leszczynski et al. Applicability of Discovery Science-Approach to Determine Biological Effects of Mobile Phone Radiation. Proteomics 4, 2004, 426-431.

The inescapable conclusion is that AGNIR Report 2012 is not a comprehensive review of the relevant science and it is a biased review.

Q. On September 12, 2012, the Norwegian Institute of Public Health published a report, *Low-level radiofrequency electromagnetic fields - an assessment of health risks and evaluation of regulatory practice.* Do you agree with the conclusions of this report?

A. The 204-pages long report is written in Norwegian and, therefore, I was not able to read details of the scientific evaluation of the analyzed studies. However, similar to the AGNIR Report published earlier in the year, the list of references cited in the report suggests some kind of "selectivity". For example, yet again, research from my group at STUK is not mentioned in the report - not a single reference to any of our numerous studies (see my full CV). It is deeply disturbing and it seriously undermines the reliability of this and other reports when the authors omit without justification some of the well-known relevant scientific studies.

Q. What is your view of the "weight of the evidence" analyses relied upon by AGNIR and some standards-setting agencies to conclude that exposure to low-level RF has no biological effects or poses no health risk?

A. The "weight of evidence" is often abused by those who wish to disregard scientific studies showing that mobile phone radiation can induce biological effects.

When evaluating the possible health effects of RF, as with any other environmental factors, no matter naturally occurring or man-made, there are needed several types of scientific evidence such as (i) the possible mechanism how the effect is induced in living organism, (ii) in vitro laboratory studies that confirm the existence of the biophysical and biochemical mechanism of the effect, (iii) animal studies, including long term effects and toxicology, (iv) human volunteer studies, and (v) epidemiological evidence of the effect on human population at large.

In each area of investigation (epidemiology, human volunteers, animal studies, laboratory in vitro experiments and biophysical mechanisms) there are both positive and negative studies and by the sheer numbers, in some areas, the negative studies outweigh the positive ones, but in some areas the opposite is true. The "weight of the evidence" is sometimes used to reach a no-effect-conclusion because the outcome of the majority of published research studies is negative. This argument is used, and often abused, to support the notion that there are no proven effects on health below the present safety standard limits. Negative studies seem to be accepted without much scrutiny, whereas the positive studies are examined in every detail to determine why the result is positive. Hence, the positive studies are not treated equally with the negative ones, even though also the negative studies might include erroneous results or interpretations. Moreover, only the positive studies are demanded to be replicated before they can be accepted as valid scientific evidence.

At least the negative studies that are considered as providing the crucial evidence of no-effect should be replicated. An error in study design, execution, data analysis or interpretation might lead not only to positive but also to negative result. Furthermore, many of the positive studies are not even being attempted to be replicated and of course negative studies are not replicated at all. However, if the replication of the positive study is attempted then, commonly, the protocol of the replication study has so many modifications, introduced to improve the quality. That causes that the outcome of such "replication" study is difficult, if not impossible, to compare with the original one. As often happens, the outcome of the so-called replication study differs from that of the original study. However, the failed replication might be either because of incorrect (unreliable) result of the original study or because of the modifications introduced in replication study. Usually, this question remains unanswered but the final result is often claimed to be: in summary, the original study has not been replicated (= is not valid evidence).

Sometimes there may be good explanations for the different results that are not properly considered in "weighing" the evidence between positive and negative

studies. Some of the in vitro studies suggest that mobile phone radiation and other low-level RF might alter cell physiology e.g. by triggering cellular stress response, causing DNA damage, altering gene and protein expression. However, there are also studies that do not indicate such effects. One of the reasons for such discrepancy might be, as postulated in some studies, that genes and proteins expressed (=active) at the time of exposure to mobile phone radiation might play a decisive role in the induction of the effects.

In this context, well designed, well executed state-of-the-art studies with the best available radiation exposure dosimetry, might not be sufficient to cause any change in thinking about low-level RF radiation effects. Other negative studies, of which many were poorly designed or executed or had poor dosimetry design, provide "weight of evidence" against any effects.

Q. Based on your own review of all of the relevant scientific studies on the subject, what is your opinion about whether exposure to low-level RF has biological effects and whether it can cause adverse health conditions in humans?

A. Safety standard-setting agencies, such as ICNIRP or ICES, are assuring users that there is no proven health risk and that the current safety limits, on RF exposure, protect all users. However, **based on the available scientific evidence, such conclusions are not justified**. **There are many reliable, well-designed studies showing positive results that cannot be considered outweighed by negative studies or inconsistencies.** ... (Underlining and emphasis added.)

...

Q. In your opinion, could a careful scientist familiar with the body of knowledge on the subject reliably conclude that there are no risks of adverse health effects from the exposure to mobile phone radiation and other like radiation types?

A. No, as I stated above, **I think that at this time any statements suggesting conclusively that there "is no health risk" are premature and not reliably supported by the available scientific evidence.** (Underlining and emphasis added.)

[Leszczynski testimony - End quote]

EXHIBIT 1F (FD):
Pre-filed Testimony of Dr. De-Kun Li, MD, PhD, MPH, MPUC Docket No. 2011-00262. https://ecfsapi.fcc.gov/file/7520940945.pdf

Dr. De-Kun Li, MD, PhD, MPH, Senior Research Scientist, Division of Research, Kaiser Permanente, and faculty member, Stanford University Department of Health Research and Policy. Dr. Li is an epidemiologist with extensive experience in studies relating to pregnancy and early childhood diseases and has published five peer-reviewed papers on EMF health effects of environmental exposures to magnetic fields, including their impact on reproductive systems and adverse pregnancy outcomes. Dr. Li also has served on multiple occasions as an expert review panelist for the National Institutes of Health (NIH) and as associate editor of the American Journal of Epidemiology. He also has been a panel member on invitation by the National Academy of Science. Further reference to Dr. Li's educational and professional background and experience appear on pp. 1-3. Dr. Li's curriculum vitae and prolific number of peer-reviewed research publications are listed beginning with 'Li Exhibit A' following his full testimony in the pdf file (FD). His testimony reads in part:

[Li testimony - Begin quote]

Q. Have some research and epidemiological studies shown negative results for adverse health effects associated with RF exposure?

A. ... I am aware of the controversies about the health effect of RF EMF exposure, mostly from cell phone-related exposure, and reports of a potential increased risk of brain tumors associated with long-term (> 10 years) use of cell phones. Although the number of studies examining RF EMF health effect remains limited, the existing reported studies are riddled with methodological problems. Chief among them are retrospective designs [trying to ascertain RF EMF exposure *after* outcomes (e.g., brain cancer) had already occurred], and short term use of cell phone. Many of the outcomes examined (e.g., cancer) have a long latency period and take decades to show symptoms. Thus, those studies of short-term exposure which claim no effect on disease outcomes that take a long time to develop are irrelevant in determining RF EMF health effect.
...
C. ... I am not aware of any studies conducted by any entities to demonstrate that use of the smart meter with massive installation in residential areas is safe for the human population.

D. ...[T]he question becomes whether it is the consumers responsibility to demonstrate the safety of a product by being exposed to it and becoming a victim or casualty (e.g., brain cancer); or the responsibility of the producer of smart meters to demonstrate its safety before releasing it to the public. ... For a product like smart meters that almost everyone is exposed to, demonstrating its safety is the paramount responsibility of the producer.

Q. Please describe your prospective epidemiological studies related to RF exposure.

A. Over 13 years ago, we conducted a study to examine the health effect of exposure to magnetic fields during pregnancy among more than 1,000 pregnant women. It was a prospective study, meaning magnetic exposure was measured during pregnancy *before* the outcomes of interest occurred, compared to many retrospective studies of RF EMF about cell phone use. Our study was also based on objective measure of magnetic fields, meaning that we asked participating women to wear a meter that captured magnetic fields from all sources, rather than based on participant recall as in most RF EMF studies of cell phone use.

B. We first examined the health effect of magnetic fields on the risk of miscarriage. We published a paper in 2002 showing that women with higher exposure level to magnetic fields had almost twice the risk of miscarriage. The finding was widely reported by the international media at that time. ...

C. We then followed the offspring for up to 13 years. We published two papers, one in 2011 and another in 2012 reporting that children of mothers who were exposed to higher levels of magnetic fields during pregnancy had a higher risk of childhood obesity and asthma (3-6 times higher in some cases). There was a dose-response relationship, meaning that the higher the maternal exposure level of magnetic fields was during pregnancy, the higher the risk of asthma or childhood obesity in their offspring. The papers were widely covered by the news media.

D. The important strengths of both findings are the prospective design and objective measure of exposure levels of magnetic field, both of which would lead to more accurate measure of magnetic field level. When magnetic fields were not measured correctly, like in those studies based upon participants' recall, the resultant finding is "no adverse effect" due to what we call *non differential misclassification of exposure*.

Q. Are there plausible mechanisms by which non-thermal biological effects associated with RF exposure could result in cancer or other adverse health effects?

A. ... Skeptics have been focused on the EMF thermal effect, especially those who are NOT in the profession of biomedical research, such as physicists or engineers. **It is now known that EMFs can interfere with the human body through multiple mechanisms**. For example **it has been demonstrated that communication between cells depends on internal EMF signals, likely at a very low level**. External EMFs could conceivably interfere with normal cell communication, thus disrupting normal cell differentiation and proliferation. Such

disturbance could interfere with fetal development and lead to miscarriage, birth defects, and cancer. ... (Underlining and emphasis added.)

Q. In your opinion, does the state of the science support a public policy decision concluding that exposure to RF from wireless smart meters is safe?

A. **No.** ... In fact, emerging reports, though still limited, are starting to show possible links to adverse health outcomes, especially with long-term exposure. (Emphasis added.)

B. **I am not aware of any studies that have shown that exposure to smart meters is safe for the human population. Anyone who wants to install smart meters to every household needs to conduct studies to demonstrate that such massive installation is safe and will have no effect on the risk of cancer, miscarriage, ... asthma, autoimmune diseases, etc.** (Emphasis added.)

C. Exposure to smart meter RF EMF is different from exposure to cell phone RF EMF in several important ways:

a. First, cell phone use is usually for a short duration. However, a smart meter, if installed near or outside the location within a residence that people are frequently occupying (such as bedrooms, living rooms, nurseries, etc.,) creates exposure to RF EMF that could last many for hours.

b. Use of cell phones is a voluntary exposure. One can choose not to use a cell phone. Vulnerable populations like infants and young children currently are not exposed to cell phone RF EMF in most cases. However, every resident, including infants, pregnant women and the fetus, in a household will be exposed to RF EMF from smart meters if installed nearby. Given that installation of smart meters is mandatory in most places, RF EMF exposure from smart meters is an "involuntary" exposure. **Based on the principle of risk assessment, involuntary exposures require more stringent safety standards**. (Underlining and emphasis added.)

c. Because of the nature of involuntary exposure, many susceptible populations including pregnant women, young children, and those who are sensitive to RF EMF are being equally exposed. Susceptible populations usually have much lower thresholds of exposure level.

[Li testimony - End quote]

EXHIBIT 1G (FD):
Pre-filed Testimony of Dr. Richard H. Conrad, PhD, MPUC Docket No. 2011-00262. https://ecfsapi.fcc.gov/file/7022117939.pdf

Dr. Richard H. Conrad, PhD, Biochemistry, Johns Hopkins University, postdoctoral research in Department of Biochemistry, Cornell University and at the Institute of Molecular Biophysics, Florida State University. Dr. Conrad, himself a sufferer of electro-hypersensitivity, is an expert and consultant in the field of EHS. He also is an inventor who holds numerous patents. Further reference to Dr. Conrad's educational and professional background, publications and experience appear in his curriculum vitae and are listed beginning with 'Conrad Exhibit A' following his full testimony in the pdf file (FD). His testimony reads in part:

[Conrad testimony - Begin quote]

Q. Have you studied the phenomenon of Electrical Sensitivity associated with exposure to radio frequency radiation?

A**.** Yes, in great depth. I have a great deal of experience with Electrical Sensitivity/ES/EHS from having it myself, from having consulted with hundreds of people suffering from it, and by reading the scientific literature on non-thermal effects of RF/EMF and on Electrical Sensitivity. I recently conducted a survey of people who have experienced electrical sensitivity related to smart meters (Smart Meter Health Effects Survey).

Q. What is your expertise pertinent to Electrical Sensitivity and to the Smart Meter Health Effects Survey?

A. I am highly qualified for designing and analyzing the "SMART METER HEALTH EFFECTS SURVEY" because I am in the unique position of:

1. being an expert in hands-on experimental research design, analysis and reporting;

2. having an in-depth academic training and knowledge of biochemistry, biophysics, spectroscopy and biocompatibility;

3. having an extensive knowledge and love of electronics, having designed and built dozens of different types of electronic devices, and was an amateur radio operator;

4. being a paid consultant having talked to and helped hundreds of persons with ES/EHS (Electrical Sensitivity/Electrical HyperSensitivity) and MCS (Multiple Chemical Sensitivity) issues over the past ten years;

5. being electrically sensitive myself for 15 years, therefore knowing EHS from the inside out;

...

Q. What are your own experiences with Electrical HyperSensitivity/EHS?

A**.** I became electrically sensitive 15 years ago. I offer a complete account of my own experiences in the attached Exhibit B, which I incorporate into my testimony by reference.

Q. What are your conclusions about the current state of the science on EHS and the effects of RF on humans?

A. Based on my review of the science, it is my opinion that there are many common misconceptions about effects of EMF and about EHS (Electrical Hypersensitivity). The criticism that there are no plausible mechanisms for biological effects from low levels of RF exposure is totally invalid. I briefly summarize these points below, and provide a more comprehensive expert opinion statement attached as Exhibit C, which I incorporate into my testimony by reference.

A first serious misconception: *"if EMF levels are not high enough to cause bulk heating of tissue, then there cannot possibly be any effect"*.

A second serious misconception: *"if the average power level is below a certain safe standard, then a device is safe, and it does not matter whether the RF is continuous or pulsed"*.

A third serious misconception: *"Electrical sensitivities are not real because people only imagine that they are sensitive to EMF; they took on these sensitivities out of paranoia after having heard about them from others; the nocebo effect*."

There are innumerable possible mechanisms, but in research, to insist on being able to conceive of mechanism before accepting good reproducible data is a clear sign of scientific incompetence.

Q. Describe your consulting services and what you have learned from speaking with your clients.

A. Every week I get calls from new people (who find me via my website www.conradbiologic.com) who say they have recently become electrically

sensitive; especially lately, with the installation of so many smart meters. They call me for consulting help to reduce their electrical exposures from their computer and other devices in their office or home. I first question them in great detail, because I don't want to waste my time chasing psychological stuff. What I have found is:

1. There are a few (very few) persons I have talked to who, due to a high level of suggestibility and fear, thought they were sensitive to EMF and were obviously not (the nocebo effect). ...

2. Then there are some who become truly sensitive to some sources of RF and later become fearful that they are also sensitive to some other sources that they are not really sensitive to, due to a layer of "understandable" paranoia generated by really having suffered so much from something they could not see, hear, smell or touch. Especially those that tend to get emotional about it.

...

4. In many persons with true electrical sensitivities, EMF exposures known or unknown can have an effect on the physiological functioning of the mind and hormones, causing ADD, migraines, neurologically induced stress or depression, etc.

5. Because of the severe limitations placed on their lifestyle by their very real (although usually invisible) disability, psychological stress and/or depression can understandably result on top of all this.

6. There are many people who are astute, completely level-headed and sane, like the numerous scientists, engineers, programmers, financial advisors and realtors I have talked to, who love their work and their computers but are truly disabled because they can't sit in front of a computer for more than a few minutes without having debilitating symptoms and so can't work anymore, they can only drive an older car with the early, less powerful computer under the hood ..., can't travel into many environments, their partners and friends leave them because they are not willing to believe or accommodate them, etc. It goes on and on, and gets worse and worse, and worse. EHS is very real.

EHS is similar to the situation with food allergies: a person who is allergic to a particular food will react to it whether or not they know it is a hidden ingredient in a mixture, a soup, for example. And most would not choose, either consciously or subconsciously, to be restricted in their choice of foods, or to feel worse after eating instead of better. It just happens. And people who have never experienced food allergies themselves often disregard it - they may accept the concept intellectually and yet at the same time not believe it at the emotional level ... . It would not be difficult for one person without food allergies to convince another who had never

experienced allergies, that food allergies do not really exist in anyone. By analogy, this is likewise true in the case of EMF sensitivities.

Another analogy between EHS and food allergies: most people with EHS are much more sensitive to certain frequencies than to other frequencies. You won't get a positive result by challenging a person with wheat if they are allergic to dairy only. Thus if you are doing an experiment to test for the reality of EHS, you have to test the person to frequencies he or she is sensitive to. In such testing there are many variables, some of which are uncontrollable or unknown. Variables that must be controlled or taken into account include: recent exposures, current background exposures, current state of homeostasis/health/circadian rhythms of the person (or of the animal in animal studies, or of the cell culture in the case of in vitro studies). The above analogies also hold true for chemical exposures in persons with Multiple Chemical Sensitivities.

Q. What further evidence do you have that EHS is real?

A**.** The "anecdotal" evidence from day-to-day life supplied by persons who themselves have EHS (who are the real experts in this field), is very strong. It actually has all the elements of good science:

1. Totally blinded experiments with internal controls (at first, subjects were usually naive, and later, many exposures were inadvertent and only discovered after the fact).

2. Careful observation (pain is hard to miss, and is well-remembered).

3. Consistency and specificity; experimental results reproduced with similar results, dozens or hundreds of times:

A) in each sensitive individual (EMF exposure resulting in symptoms, then more EMF exposures resulting in similar symptoms, usually many times per month); amplified by nearly identical experiences in the form of inadvertent experiments by:

B) each of hundreds of thousands of sensitive persons who at first had never heard of EHS from anyone, each person having the same results.

4. Repeated, strong and direct correlation between specific cause and specific effect, closely related in time: EMF exposure repeatedly and rapidly resulting in uncomfortable, painful symptoms. This clearly shows that the smoking gun is EMF exposure.

Q. Please give a summary of the most common symptoms of EHS.

A. The symptoms fall into a typical group. Many of these seem to be generated by neurological changes and/or inflammation and include heart palpations or arrhythmia, burning skin, tinnitus/microwave hearing, unusual headaches and insomnia. The symptoms are often diffuse, and should be expected to be so because they appear to involve systems of the body that are completely diffused throughout the body: the biochemistry of the cells, and the nervous system, endocrine system and immune system.

Q. How did the Smart Meter Health Effects Survey come about?

A. As of six months ago I had never heard of smart meters. Then over the course of a few weeks I began receiving calls to consult for newly electrically sensitive people who asked me to advise them how to modify their computer set-up so they could tolerate using it. Many of them said they had never heard of electrical sensitivities before, were developing strange symptoms they never had before, could not use computers, wi-fi or cell phones any more without painful symptoms (even though previously they had been using them heavily with wi-fi in offices and on in homes 24/7). Weeks or months after their symptoms began they first discovered a smart meter on their home. Upon inquiry, they found out it had been installed at the time or just before their symptoms initiated. Many of them had not even known or cared what a smart meter was before this. But then, intelligently (not fearfully) they began to make correlations: when they got closer to the smart meter, their symptoms got worse, and when they went further away, their symptoms lessened. All this was surprising to me because this device was initiating ES in previously normal, healthy persons who had tolerated wi-fi and cell phones for years with no problems.

Then I began reading the testimonies of others whose electrical sensitivities had been initiated, or in cases where the person already had ES, worsened considerably, by exposure to smart meters. Curious, I started to study the characteristics of smart meters, and even spoke to Ric Tell, the electronic engineer expert who has made measurements on smart meters for industry, to try to understand why these relatively low-power microwave transmitters could have such an effect. There are a number of possible reasons, which I will discuss later, but at this point the answer is unknown. In spite of not understanding how and why, it began to appear to me that the smart meters might really be unsafe for at least some people, in the short-term. What struck me most was the common time-line: normal people, strange new symptoms, and only later discovered that a smart meter had been installed. This is not mere anecdotal evidence, but is equivalent to double-blind experiments, and it was being reproduced many times by many naive persons. But in their testimonials not everyone gave all the facts to enable a careful and objective analysis, and

teasing the data out of many testimonials all written in different styles would have been a daunting task.

I saw these people were really suffering with what appeared to be a common array of diffuse neurological and other symptoms, that it seemed to be due not to fear or psychological factors, but to the smart meters and it was destroying their lives. So I wanted to help, and since no one else was collecting the data to try to discover what was really going on as far as health issues in the short-term, the survey began to take shape in my mind.

Q. What is the purpose of the Smart Meter Health Effects Survey?

A. The purpose was to develop reliable data much more solid than ordinary anecdotal evidence, about possible smart meter health effects, and their time-line (development of symptoms in relation to installation of smart meter in relation to knowledge of meter's presence). My purpose was to obtain a database for analysis to see whether or not smart meters are really the cause of people's reported symptoms - letting the data speak for themself - to see if smart meters are unsafe as far as health is concerned. Two of the key questions I want to answer are:

1) do smart meters initiate electrical sensitivities in previously normal persons, and

2) do smart meters worsen the electrical sensitivities in persons who were already electrically sensitive?

Q. Is this survey a prevalence survey?

A. Definitely not. That is not its purpose at all. We did not survey the general population, but only solicited responses from persons who already felt that they had experienced health effects/symptoms from exposure to smart meters. We have made no attempt to collect data on prevalence of health effects from smart meters in the overall population. We only wish to establish whether or not smart meters are actually the cause of health effects in the persons who feel that they have already made such a correlation.

Q. Was not a previous smart meter survey and its summary report distributed in 2011?

A. A "Wireless Utility Meter Safety Impacts Survey" was conducted in 2011 by the EMF Safety Network, and its report is available on-line. It did collect much useful information, including on specific symptoms, but its main emphasis was not on health effects. It did not ask detailed enough questions to establish a time-line, nor did it ask whether people were initially normal without sensitivities, or had ES

before their smart meter. My Smart Meter Health Effects Survey is specifically about health effects and asks many more detailed health effects questions.

Q. What safeguards does the survey incorporate to recognize mistakes or to prevent bogus answers?

A. A number of the most critical questions are asked in a few different ways, and on different pages of the survey, in order to provide a cross-check against possible mistakes and bogus answers. (It is a forward only survey, which means that the respondent cannot go back to see how they answered a previous version of a similar question, nor can they change an answer on a previous page). In the approximately 20 cases I found where answers conflicted, I called and spoke to the respondent and carefully asked them the question(s) again in a way so as to avoid biasing their answer, and edited the survey accordingly, with their permission. All except about 10 respondents had supplied first name, last name and mailing address (in most cases a street address) and most also gave a phone number and/or email. In the 3 cases where the person was not reachable, I converted an impossible answer to n/a. About 5 surveys were clearly bogus, and I excluded these.

I carried out a search to find all cases where more than one survey had come from the same IP address. I found five instances, and checked all of them out carefully: one was a mother and adult daughter both affected by smart meters, one was housemates both affected, two were husband and wife both affected, and one was a woman who had taken the survey twice because she had changed her mind about some answers. When I emailed the latter, she could not confirm that her symptoms were from smart meters, so I excluded both of her surveys.

Q. What are the conclusions of the Smart Meter Health Effects Survey?

A. A copy of my report with a summary of survey results is attached as **Exhibit D.**[1] **The survey results provide very strong evidence that smart meters are causing painful and debilitating new symptoms in many previously normal healthy people**, and causing them to become electrically sensitive to a whole range of electronic devices including Wi-Fi, cell phones and computers. Because of exposure to smart meters, people are becoming electrically sensitive at an unprecedented rate. Many of these people had previously lived with Wi-Fi in their homes on 24/7, worked in offices with Wi-Fi and many computers all day long, and had used a cell phone, all without symptoms. This includes professionals from all walks of life: doctors, dentists, nurses, teachers, realtors, salesmen, and many who absolutely needed their computers for their work and had loved their electronic devices: computer programmers, electronic engineers, accountants and graphic artists. (Emphasis added.)

[1] The complete set of survey data is available upon request. Because the production of this report was rushed to meet the testimony deadline in large part because of technical difficulties at Survey Gizmo, further compilations and summaries of the survey data may be produced with supplemental testimony.

Q. What are some common effects on people of the symptoms reported in the Survey, and when do these symptoms appear and disappear?

A. The symptoms caused by smart meters are often disabling, and are sometimes painful to the degree of torture. Since smart meters and the cell phone towers that smart meters have sensitized people to are almost everywhere now, these people have no place to go to escape. They are trapped (unless they can afford to buy a huge ranch). They are trapped in a hellish situation, not one of their own making. This Survey has demonstrated that the personal evidence is equivalent to hundreds of double-blind experiments, and is not psychosomatic or mass hysteria. These unfortunate people bear none of the responsibility. The responsibility falls solely on new technology - particularly smart meters, and the people who implemented them without any biological conscience, without conducting a human impact study (while distributing a large amount of propaganda in an attempt to proactively counter the thousands of research papers that demonstrate biological effects of non-thermal levels of microwave radiation). Would hundreds or thousands (or millions worldwide) of initially naive persons, many of them astute, independently choose such a disability because of some form of mass hysteria? This is an illogical conclusion due to either a lack of intelligence, being misinformed, or having vested interests combined with lack of ethics. Therefore people with EHS, the real experts, whose vested interests are biological - human health, human rights and biocompatibility - are those who should be listened to, rather than engineers and businessmen with technological and financial vested interests.

It is extremely important to note that in 42% of the survey respondents, the symptoms and sensitization began before, (often months before) they knew that there was a smart meter present. Many of these persons had never heard of electrical sensitivities before their symptoms began, and some had never heard of a smart meter. Thus this evidence is not merely anecdotal evidence, but is good scientific evidence, obtained in double-blind experiments reproduced in many, many people. These smart meter effects cannot possibly be psychosomatic, in spite of publications that claim otherwise.

Q. Please describe the Survey results in more detail.

A. Setting aside all prior research results and papers good and bad, biased or not, preconceptions, debates about mechanisms and non-thermal effects, calculations

right and wrong, theories, microwave power levels seemingly too low to have any effects, vested interests, fears of EMF or of cancer risk or other possible long-term health effects; the survey results show that in:

1. 210 survey respondents,

2. the majority well-educated (9 PhDs, 1 MD, 1 DDS, 42 MS or MA, 70 BS or BA),

3. many initially healthy and normal, without sensitivities, using WiFi, computers and cell phones without symptoms,

4. many had no prior knowledge of electrical sensitivities and had not cared one way or another about smart meters,

5. all began to develop painful symptoms very typical of electrical sensitivities (including loud tinnitus, heart palpations or arrhythmias, burning skin, severe headaches, neuropathies, difficulty concentrating, sleep problems and more) soon after their smart meters were installed,

6. where 42% of them were not even aware that a smart meter had been installed on their home until after they developed symptoms (a double-blind "experiment"), and 16% did not develop symptoms until weeks or months later (if they were going to have psychosomatic symptoms, these would have developed in minutes, hours or days, not weeks or months), and

7. when they were able to have the smart meters removed, their symptoms lessened usually immediately, sometimes completely, and usually leaving them with electrical sensitivities where they no longer can use their electronic office equipment at all, or only for very short periods of time.

To any logical mind, the above 7 points, when viewed together constitute solid scientific evidence. Evidence that indicates there is something as yet undiscovered about smart meters that is causing them to sensitize people to EMF - to develop Electromagnetic HyperSensitivities (EHS). This is a real, seriously disabling and growing problem that will not go away by itself. It is not psychological in spite of understandably sometimes having emotional or psychological overlays, but these are only layers on top of very real physical, physically caused symptoms. Many of these persons have had to leave their homes and careers. Sometimes everyone in the family develops symptoms.

In some cases the problems were due to banks of 30 to 60 smart meters within 10 feet of their apartments or beds, but in many cases people have been affected only

by their own single meter on a private home in a residential district with spaced-apart houses.

I am writing here about real people and real suffering. **Presently more and more people are developing EHS worldwide at an alarming and unprecedented rate (O. Hallberg & G. Oberfield, Electromagnetic Biology and Medicine, 25: 189–191, 2006, attached as Exhibit E). The total number is already huge** - we shouldn't have to wait until the numbers grow even larger to get help - the number of people already affected is enough to require doing something about it. These people will have no place left to go, and no careers. Smart meters are an experiment carried out by utilities and others mostly for their own profit, without prior safety testing, and it appears to be a classic example of technology creating far more problems than it solves, problems of all kinds that will persist and increase. It will be like swallowing an endless string. There will be no end to health problems, health costs and financial costs. Smart meters as they are today are extremely flawed - an overly complex system being propagated worldwide without any human impact study. There are far smarter ways to implement a smart grid. If a technology is not carefully and properly designed to serve human beings, then human beings end up being slaves to (and in this case, injured by) the technology. (Emphasis added.)

Furthermore, EHS sensitization and the resulting outcry against smart meters does not originate as a coherent or mass phenomenon. It consists of many separate individual occurrences arising independently again and again in naive individuals, in countries all over the world. After they discovered that others also had similar symptoms following smart meter installation, people banded together to assert their rights. Here is an excerpt from an email I received recently from British Columbia, Canada: *"I am getting emails almost daily from people suffering health effects from being near these meters. Many have never heard of sensitivity, allowed the meters because they had no concerns, and are now suffering from tinnitus, disturbed sleep, headaches, palpitations – the classic symptoms of sensitivity."*

Q. What is your opinion about why smart meters are making people electrically sensitive?

A**.** There is something unique about the RF emissions of smart meters, in spite of their average power being very low, that makes them more sensitizing than Wi-Fi or cell phones. It is surprising that they are so sensitizing, but that is the reality. Electroni engineers underestimate the sensitivity of biological systems, just as chemists did until recently. We do not know why smart meters are so sensitizing. The manufacturers do not reveal enough of the design and operational details for us to know, and some of what they have revealed has turned out to be untrue. The measurements are hard to make on networks in the field. The culprit may be the

microwave pulses themselves radiated through space to the person, or first propagated closer to the person via conduction on house wiring and then radiated.

Some clues:

1. Many persons who managed to avoid having a smart meter on their own home were affected by the neighbors' smart meters.

2. AMR meters were problematic, not just AMI.

3. Smart meters whose transmitter was supposedly turned off were problematic. We may be able to tease more information about these points later from the Survey data.

Questions that it would help to have answers to:

1. Are some brands of meters worse (more sensitizing, more painful) than others?

2. Which is worse: meters that use FHSS (Frequency-Hopping Spread Spectrum), or those that use DSSS (Direct-Sequence Spread Spectrum) data transmission protocol?

3. Are the meters that are causing problems simply not within specs?

4. How much of the microwave pulses, and/or of the noise from the switching power supply actually gets onto the power line/house wiring?

5. What is the peak amplitude of the pulses? Is it greater than the 1 or 2 watt rated output of the transmitter, even though the average power and duty cycle are low?

6. Exactly what is the fine structure of each pulse (both of data pulses and of any other mesh network pulses), and what is the frequency of the hopping, if any? In frequency hopping, is there a time gap between hops, or does the signal look continuous within each overall data pulse? A frequency hopping transmission changes channels at regular intervals which are sometimes in the range of approximately 10 hops per second - this essentially constitutes 100% AM modulation at an important biological frequency - 10 Hz (http://www.audiotel-support.com/site/appnotes/Spread Spectrum transmissions.pdf).

We need to see scope traces of smart meter outputs at various time bases, even slow traces, say 1 minute full screen, and also and particularly at 1 second full screen to look for the known biologically relevant frequencies of 2 thru 60 Hz. People can take measures to avoid or filter polluted air or water, but they cannot avoid or filter

or effectively shield EMF. Even with opt out or opt in programs, neighbors and all businesses will still have smart meters. Sensitive persons will have to move, with very, very few affordable practical places to go, and will be denied access to businesses and offices for employment purposes, access to medical care, shopping and everything else. An analogy would be to blanket the earth with peanut dust; a certain percentage of people would become and remain very ill, or worse.

Q. What do many Electronic Engineers say about smart meters?

A. Many electronic engineers and the politicians and utilities that listen to them are of the opinion that the levels of EMF emitted by smart meters are so tiny they cannot possibly have any effect on humans. They firmly believe this because:

1) these levels are below the thermal "safety" limit the FCC has set,

2) they consider the results of research on non-thermal effects very controversial,

3) they erroneously believe that one cannot accept research results until one can prove or at least imagine a mechanism first,

4) since they are experts in electronics, they unconsciously assume that their expertise carries over into being able to make judgements about possible effects of EMF on humans, and

5) they are not aware that they have experienced any effects themselves.

I respond with realities:

1) The FCC limit is not biologically relevant since it is only a thermal limit, i.e. the limit before appreciable bulk heating of meat begins, and it is a time average which does not factor in biologically important frequencies or the biologically relevant peak power. In a letter written by Norbert Hankin of the US EPA Center for Science and Risk Assessment, Radiation Protection Division (see attached Exhibit F, incorporated herein by reference) he said "*the generalization by many that the (current FCC) guidelines protect human beings from harm by any or all mechanisms is not justified."* (Emphasis added.)

2) Most engineers don't have enough knowledge of molecular biology to realize that many possible high-gain mechanisms do exist that could account for non-thermal effects.

3) There are many hundreds of research papers showing non-thermal effects, but funding to confirm the results or to do more research in this direction has dried up.

Industry has flooded the journals with research and review articles that are very heavily biased in the opposite direction. I discuss this further in my attached Exhibit C, incorporated herein by reference.

Therefore, discussions based on FCC limits, engineering opinions, beliefs or research results are as unproductive as arguing over interpretations of the Bible, and none of the above is very useful to us at the present time. **What we do have in the Survey is real-world solid evidence that real people have actually been injured and continue to be injured by smart meters, in spite of the opinions of engineers.** (Emphasis added.)

Where did the highly erroneous concept originate that you need to prove a mechanism (or even need to be able to imagine a mechanism) before accepting data? This is the exact opposite of the creative scientific attitude that can result in breakthroughs. Many people are afraid of breakthroughs; they rock the boat and the vested interests. Wherever it began, this false concept has of course has been taken up by industry and government as a battle cry, then parroted by the media, and now everyone believes it, even most "scientists".

Q. Based on your studies, your work with EHS sufferers and your survey results, what are your opinions on the question of whether smart meters are safe or "unsafe"?

A. What does it take for smart meters to be considered unsafe? What % of the persons who have smart meters on their residences, or what actual number of persons, would have to be shown to have been harmed with certainly by smart meters? 0.1%? 1.0%? 5%? 10%?; 1,000 persons? 10,000 persons? 100,000?

What constitutes a threat of harm to the health of normal persons? If 1% of normal persons are made ill from smart meters, this means that if a normal person has a smart meter installed on their home, there is a 1% probability of harm. Would this not be a threat?

If a government agency or a corporation was forcing the deployment of technology on citizens that was known in advance to cause disability or significant harm to one out of every 100 citizens, would this amount of harm be "acceptable" or would it be cause to halt such deployment? What would the probability of harm have to be to be prevent deployment? The actual acceptable limit chosen would probably be proportional to the perceived degree of necessity of the particular technology. Most technology is not as necessary as we think it is. There is always a safer design. The precautionary principle is the only ethical way to proceed.

AN INCONVENIENT TRUTH: smart meters are sensitizing hundreds of

thousands, maybe millions of people all over the world to become Electrically HyperSensitive, regardless of the stubborn adherence of industry and the FCC to thermal "safety" standards. Their response to non-thermal evidence is to ignore, disregard, deny, and above all, disbelieve. They neither conduct nor support unbiased non-thermal effects research.

Elihu Richter, MD, MPH, Hebrew University-Hadassah School of Public Health and Community Medicine: "Were these population-wide exposures to smart meters to be part of a project carried out in a medical setting, to test the risks and benefits of a new technology on human health and well-being, it would be rejected by a Medical Institutional Review Board on ethical grounds as an unethical exercise in human experimentation."
(http://sagereports.com/smart-meter-rf/docs/letters/Eli_Richter_CCST_-final.pdf)

Q. Do you have further thoughts for the Public Utility Commission to consider about opt outs, the FCC and possible solutions?

A. Yes, I offer additional comments on these subjects in the attached Exhibit G and incorporate them into my testimony by reference. Please also see copies of individual surveys attached as Exhibit H, submitted with the authorization of the individuals.

[Conrad testimony - End quote]

EXHIBIT 1H (FD):
Pre-filed Testimony of Lloyd Morgan, MPUC Docket No. 2011-00262. https://ecfsapi.fcc.gov/file/7022311323.pdf

L. Lloyd Morgan, BSEE, Electronic Engineering, UC Berkeley; Senior Research Fellow, Environmental Health Trust, Senior Advisor, Radiation Research Trust, and member of the Bioelectromagnetics Society (BEMS) and the Brain Tumor Epidemiology Consortium (BTEC). Further reference to Lloyd Morgan's educational and professional background, published papers and experience appear in his curriculum vitae and are listed beginning with 'Morgan Exhibit A' following his full testimony in the pdf file (FD). A substantial portion of his testimony illustrates misinformation tactics used by industry and explicates a number of direct conflicts of interest and the pervasiveness of industry influence over safety standards-setting bodies and regulatory agencies. Reads in part:

[Morgan testimony - Begin quote]

Q. Are you familiar with peer-reviewed epidemiological studies addressing the risk of cancer, disease, or other adverse health effects resulting from the exposure to RF?

A. ... Yes, I have carefully reviewed every epidemiology study that I am aware of on the risk of exposure from cellphone radiation and many of the studies on the risk from exposure to electricity fields.

Q. Have some of the studies involved exposure to MWR in or near the 2.4 GHz range?

A. Yes. A number of studies involving exposure to microwave radiation in that range have shown adverse health risks from exposure to non-thermal (no measurable temperature increase) MWR. Some of them are included in the list attached as Exhibit B.

Q. Have you performed any studies or meta-analyses of different studies on the subject? Briefly describe the studies and the conclusions.

A. I participated in the cellphone meta-study, "Hardell L, Carlberg M, Soderqvist F, Mild KH, Morgan LL. Long-term use of cellular phones and brain tumors: increased risk associated with use for > 10 years. Occup Environ Med. 2007 Sep; 64(9):626-32. Epub 2007 Apr 4" which concluded, "Results from present studies on use of mobile phones for > 10 years give a consistent pattern of increased risk for acoustic neuroma and glioma. The risk is highest for ipsilateral exposure." An acoustic neuroma is a tumor on the acoustic nerve. A glioma is a cancer of the glial cells in the brain.

I was the sole author of a study, "Estimating the risk of brain tumors from cellphone use: Published case-control studies. Pathophysiology. 2009 Aug; 16(2-3):137-47. Epub 2009 Apr 7" which concluded in part, "The industry-funded Interphone study has assured the public there is no risk of brain tumors from cell phone use. Yet, a closer analysis of the data leads to the incredulous conclusion that cell phone use *protects* the user from brain tumors ($p = 6.2 \times 1\ 0^{-20}$).[2] A more likely explanation of the data is that the Interphone studies were flawed and that there is a link between cellphone use and brain tumors. The Swedish team studies [led by Dr. Lennart Hardell], independent of industry funding, have reported increased brain tumor risk from cellphone use and cordless phone use."

I was a co-author with Dr. Sam Milham on an occupational study of teachers in a small California middle school, "A New Electromagnetic Exposure Metric: High Frequency Voltage Transients Associated With Increased Cancer Incidence in

Teachers in a California School"(Am J Ind Med. 2008 Aug;51(8):579-86. doi: 10.1002/ajim.20598.) ...

I was a co-author with Örjan Hallberg in a study, "The Potential Impact of Mobile Phone Use on Trends in Brain and CNS Tumors, J Neurol Neurophysiol 2011, S5" whose results found: DNA brain cell damage has an average latency time of over 30 years before increased brain cancer rates would be expected. Mobile phone use may lead to a reduced DNA repair function resulting in about a 2-fold increase in brain cancer incidence, or with an increasing rate of initial DNA brain damage from mobile phone use a 25-fold increase in brain cancer incidence may result.

I was a listed author on a study, "Scientific Panel on Electromagnetic Field Health Risks: Consensus Points, Recommendations, and Rationales." *See* Exhibit G. I was a member of the panel which included experts from Greece, Russia, Sweden, Israel, and the United States. After an extensive review of the literature we made various recommendations for new exposure limits. It concluded:

We have shown that children and small adults absorb significantly more cell phone radiation than SAM estimates. Accordingly, contemporary cell phone standards for all of the world's more than five billion cell phones do not protect the young or the 97% of the population with heads smaller than SAM. Until SAR standards have been revised, Israel (Azoulay and Rinat 2008), Finland (YLE.fi 2010), France (Lean, 2010), India (India eNews, 2008), and the U.K (BBC, 2000) recommend limited use by children, using wired headsets, hands-free kits, texting, and keeping the mobile phone away from the head and from the body to substantially lower exposures with current cell phones.

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[2] p is the probability that a result is due to chance. In the example there was one time out of 6 trillion that this
would be a chance finding. In other words, it is very, very close to certainty.

Q. What is your opinion about the state of the epidemiological evidence relating to the association between brain cancers from long-term exposure (more than 10 years) to cell phone MWR?

A. Given the World Health Organization's finding of a possible carcinogen combined by the number of human epidemiology studies finding more than a doubled risk of brain cancer after 10 or more years of cellphone use, and with multiple animal and human cell line studies that report DNA damage, my opinion is that the scientific evidence is clear. There is a clear link between long-term microwave radiation exposure and cancer.

Q. Have you reviewed the joint testimony of William H. Bailey, Ph.D. and Yakov Shkolnikov, Ph.D., dated September 19, 2012, in this case?

A. Yes. My first reaction was to note that Exponent witnesses on behalf of the industry clients are well-known for their effective techniques of distorting the scientific evidence to create doubt about safety concerns in the service of their industry clients. I believe William H. Bailey has testified on behalf of his employer Exponent Inc. in many disputes defending utilities and other industry clients. In his book *Doubt Is Their Product, How Industry's Assault on Science Threatens Your Health,* David Michaels,[3] cites Exponent and their techniques of distortion eleven times. It is one of many "product protection firms" serving industry. **Their standard approach is to rely on inconsistencies in the science to create doubt that a product has adverse effects.** (Emphasis added.)

...

The only purpose of this "perspective" is to confuse and create doubt.

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[3] David Michaels is an epidemiologist, director of the Project on Scientific Knowledge and Public Policy, and a Professor in the Environmental & Occupational Health Department at the George Washington University. He served in the Clinton administration as Assistant Secretary of Energy for Environment, Safety, and Health. In 2006, he received the American Association of the Advancement of Science's Scientific Freedom and Responsibility Award.

Q. The Exponent testimony discusses certain reviews of the scientific evidence issued by various agencies and organizations since 2010, including reports by the International Agency for Research on Cancer (IARC); the Advisory Group on Non-Ionizing Radiation (AGNIR); the California Council on Science and Technology (CCST); the European Health Risk Assessment Network on Electromagnetic Fields Exposure (EFHRAN), the ICNIRP Standing Committee on Epidemiology; and the Swedish Council for Working Life and Social Research. Are you familiar with these organizations and agencies and their recent reports?

A. Yes, I am. I noticed that Dr. Bailey did not mention how these agencies receive their funding, who they are accountable to, or what expertise the agencies and the individuals conducting the reviews have in the science or public health risk analysis. I also noticed that Exponent did not testify much about the major scientific studies that have become available since 2010. Instead they relied on the opinions of other scientists conducting these "major reviews" without disclosing the interests, affiliations, and expertise of the scientists and the agencies, or their sources of funding.

Q. Do you have concerns about the work of these agencies and organizations and the conclusions of their reports?

A. Most of these and other agencies reviewing science for regulatory purposes have links to the industries being regulated. Attached as Exhibit C is a list of articles reporting on these industry associations and their influence on scientific reviews.

The typical conclusions of the reports cited in the Exponent testimony are stated in the negative - basically stating that there is not enough evidence yet to establish or confirm the causal[4] link between low-level RF exposure and health risks. That is to create uncertainty and doubt in favor of their industrial clients. Because their client is industry the impacts on the consumer or the public are not adequately considered. The evidence of non-thermal biological effects from radio frequency radiation is overwhelming but the scientists appointed to these agency review boards are so influenced by their industrial affiliations, consciously or not, that they use the subjective process of "weighing the evidence"[5] to disregard the hundreds of studies confirming biological effects and to give the benefit of the doubt to the industry.

Here are just a few examples of their associations with industry.

The chairman of AGNIR is Professor Anthony J Swerdlow (AJS). He is also an ICNIRP Commissioner. Professor Swerdlow's conflicts-of-interest with the cellphone industry were disclosed in an ICNIRP paper which stated:

Funding for research by M.F and A.J.S. has been provided by a number of sources, including the European Fifth Framework Program; the International Union against Cancer, which receives funds from the Mobile Manufacturers' Forum and the GSM Association; the Mobile Telecommunications Health and Research Programme; the Swedish Research Council; AFA Insurance; and VINNOVA (Swedish Governmental Agency for Innovation Systems). VINNOVA received funds from TeliaSonera, Ericsson, and Telenor ... A.J.S. holds shares in the telecoms companies Cable and Wireless Worldwide and Cable and Wireless Communications. A.J.S.'s wife holds shares in the BT group, a global telecommunications services company.

Professor Ahlbom is an epidemiologist who has consistently denied the existence of brain tumor risks from mobile phones and more or less acted as a spokesman for industry in Europe. IARC removed him from its panel of experts evaluating the cancer risks posed by mobile phones, when it discovered his undisclosed conflict of interest. He was a director of his brother's consulting firm, Gunnar Ahlbom AB, which was established to help clients m the telecommunications industry on regulatory Issues. It has been reported that Ericsson, the telecom company with networks handling 40% of all mobile phone calls made in the world, is a client of Gunnar Ahlborn AB.

Professor Ahlbom was the lead author of the 2012 report by the Swedish Council for Working Life and Social Research. Exponent cites Ahlbom's report for the following dubious conclusions.

Extensive research for more than a decade has not detected anything new regarding interaction mechanisms between radiofrequency fields and the human body and has found no evidence for health risks below current exposure guidelines. While absolute certainty can never be achieved, nothing has appeared to suggest that the since long established interaction mechanism of heating would not suffice as basis for health protection. (Ahlbom 22 et al., 2012, p. 31).

This statement completely ignores the IARC 2B finding and other major scientific studies, and demonstrates Professor Ahlbom's clear bias in favor of the industry. The report does not even mention Ahlbom's own finding of a statistically significant 290% increase risk of acoustic neuroma on the side of the head where the cellphone was used. Ahlbom et al, Mobile Phone Use and the Risk of Acoustic Neuroma, Epidemiology, 2004 Nov;15(6):653-9.

The Swedish Council report mischaracterizes much of the scientific evidence. For instance, it states: "[R]eports of implausible amounts of use[6] were more common among cases than among controls (The Interphone study group, 2010)." Yet the Interphone study found a statistically significant risk, 118% increase risk of brain cancer (glioma) for cellphone use of 10+ years compared to use of 1.0-1.9 years, and an 82% increased risk of brain cancer for cumulative hours of use of 1,640 hour or more compared use of less than 5 hours. In essence, in spite of copious findings to the contrary and additional studies never cited, Ahlbom et al contend in their Swedish Council report that there is nothing to be concerned about.

Professor Ahlbom is also a member of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) and a contributor to the 2009 SCENIHR report (relied upon by Exponent), along with Prof. Mats-Olof Mattsson. According to Prof. Mattsson's 2010 declaration of interest he serves on an advisory board for Telia Sonera, the Swedish cellphone company. Another contributor to the report is Prof. Dr. Myrtill Simko, whose declaration of interest disclosed that a close family member is a consultant to the Swedish cellphone company, Telia Sonera. It must be kept in mind that the reports of these organizations represent the opinions of a few scientists (some of which such as Ahlbom are authors of several of these reports) sitting on the committees issuing the reports. As stated in the SCENIHR 2009 report: "The opinions of the Scientific Committees present the views of the independent scientists who are
members of the committees. They do not necessarily reflect the views of the European Commission." As we have seen, many of these scientists are not "independent," they are in-fact funded or otherwise influenced by industry.

In November, 2011, The International EMF Alliance, an organization independent of industry, representing hundreds of organizations, scientists and doctors issued a statement expressing concern about the "lack of transparency and pluralism in the evaluation of evidence by SCENIHR and other EU risk assessment committees." Attached as Exhibit D, is a copy of this statement. The statement criticizes the risk assessment reports for not providing a "fully transparent, traceable account of the process for evaluating evidence and drawing conclusions. In some cases summaries of reports do not correctly reflect the evidence from underlying chapters." The accuracy of these criticisms is readily apparent when reading the SCENIHR 2009 report and the AGNIR 2012 report.

ICNIRP is the standard-setting organization that all of these other agencies rely on and defer to. The November, 2011 statement by the International EMF Alliance refers to the ICNIRP's interpretation of the scientific evidence as "highly controversial." ICNIRP is accountable to no government, public health agency, or medical body, yet it opines on the "safety" of non-ionizing radiation. Besides being non-accountable, ICNIRP is a self-perpetuating organization that selects its own Commissioners. Dr. Devra Davis in her book *Disconnect, The Truth About Cell Phone Radiation, What the Industry Is Doing to Hide It, and How to Protect Your Family,* exposes ICNIRP's association with the cellphone industry. She writes (page 48):

The ICNIRP is not directly funded by industry, but a project with which half its members are tied provides financial backing from the Royal Adelaide Hospital of Australia. One would not think at first glance that hospital might be a conduit for passing along money. But, in fact, the cell phone industry for many years provided several hundred thousand dollars to the hospital, which passed it on to the WHO Electromagnetic Field (WHO EMF) project. Over the years, the WHO EMF project has evaluated cell phone risks and provided other advice to the ICNIRP regarding electromagnetic and cell phone radiation.

Michael Repacholi, who founded ICNRIP and founded the WHO International EMF Project, was formerly employed by the Royal Adelaide Hospital.

The Exponent witnesses also cite a report by the Biological Effects Policy Advisory Group (BEPAG). BEPAG was formed by the Institute of Engineering and Technology in the UK. In its 2012 Position Statement, BEPAG concluded ' ... that the *balance of scientific evidence* to date still does not indicate that harmful effects occur in humans due to low-level exposure to EMFs." (BEPAG, 2012). Again the conclusion is based on the group's *subjective* judgment "balancing" or "weighing" the positive and negative evidence. This "weight of the evidence" (WOE) process has been referred to as a '"black box' of scientific

judgment." "Without an explication of how evidence is 'weighed' or 'weighted,' the claim WOE seems to be coming out of a "black box" of scientific judgment." S. Krimsky, PhD, *The Weight of Scientific Evidence in Policy and Law*, Amer. J. of Public Health, July 2005, Vol. 95.

The Institute of Engineering and Technology (lET), is a UK professional society of engineers and other technologists who by their very nature cannot be independent of the industries that employ them. The lET is similar to the Institute of Electrical and Electronic Engineers (IEEE) in the United States, which created
the existing US exposure limits.

Exponent does not quote the following sentence in the BEP AG report: "Perhaps the greatest area of public concern remains the possibility of adverse effects from long-term mobile phone use." Although BEPAG makes reference to the 13-country Interphone study the results of these studies are not mentioned. The Interphone study found statistically significant risks of glioma and meningioma: 2.18-fold for brain cancer (glioma) when cellphone use exceeded 10 years compared to use of 1.0-1.9 years, and a 1.82-fold for use of more than 1,640 cumulative hours of use compared to less than 5 hours of use. The Interphone study reported a statistically significant increased risk of 179% for acoustic neuroma for 1,640 cumulative hours of use with 5 or more years of cellphone use.

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[4]The nature of scientific conclusions is always conditional. As the evidence of associations between an exposure and a result increases, the *probability* of cause increases. It is not the role of science to establish policy based on the evidence, it is the role of governmental agencies is to establish policy.

[5] The term "weighing the evidence" as used by industry often means counting the studies which find an effect against those not finding an effect. Because industry funds the great bulk of the studies it is not surprising when sometimes the weight falls on the side of industry. Independent scientists perform a review of the quality of each study and the source of the funding to determine where the weight of the evidence lies (Myung et al in Exhibit B). Also see additional information below.

[6] The implausible amounts of use was "This exposure category includes some highly implausible reported values of mobile phone use (e.g., 12+ reported hours of use per day}, which were more common in glioma cases than in controls." With 7,825 subjects in this study, that "some" subjects would report 12+ hours per day does not seem implausible. The reality is that "implausible" is the hook used by Ahlbom to discredit the whole lnterphone study.

Q. What is your reaction to Exponent's criticism of the IARC 2B classification for RF exposure, in which they cite a report by the German Commission on Radiological Protection (SSK) recommending a more detailed IARC rating system for carcinogenicity with eight rather than five categories?

A. To date IARC has produced 106 Monographs examining the carcinogenicity of agents. The IARC system was developed over decades with multiple experts from

many countries. The proposal would certainly serve Exponent's purpose of making the classification process overly restrictive. The worst part of the proposal is the expectation that "evidence from physical mechanisms" is required. Such a requirement is anti-science. In the history of science, it can take decades to centuries for physical mechanisms to become understood, but the lack of a physical mechanism does not negate the data. Data is gospel in science. It is reasonable to challenge the accuracy of the data, but it is irrational and anti-scientific to challenge the data on the basis that there is no known physical mechanism to fully explain the data.

In an attempt to minimize the seriousness of the World Health Organization's finding of a possible carcinogen, Exponent states that other 2B substances include "pickled vegetables and coffee." Agents that are also included (with commonly recognizable names) are: carbon tetrachloride, chlordane, cobalt and cobalt compounds, DDT, lead, magnetic fields [from electricity], nickel metallic and alloys, styrene, vinyl acetate, diesel fuel, gasoline, and welding fumes. The point is that being classified a possible carcinogen is a serious matter. Would anyone choose to be heavily exposed to any of the agents on this abbreviated list? Most of us drink coffee, but how many of us drink 10 cups a day? While most of these are not common exposures many are both common and involuntary exposures. (Underlining and emphasis added.)

Q. The Exponent witnesses cite evidence of a lack of any increased incidence of brain tumors as a basis for questioning the IARC 2B classification. What other evidence is available about incidence rates for brain cancer?

A. While there are various problems with the 3 studies Exponent cites, **what is far more important is there are now data showing increased incidence rates of brain cancer in Denmark, the United States, and Australia.** (Emphasis added.)

The Danish Cancer Registry reported in early November 2012 a doubling of the most aggressive brain cancer, glioblastoma multiforme in the last 20 years.

Dr. Devra Davis presented a poster at the American Public Health Association in October 2012 showing a significant annual increase of brain cancer (glioma) in the United States for people younger than 50 years of age between the years 1990-2009. "From 1990-2009 for males and females <20, glioma incidence increased significantly (2.2% and 1.7% APC [Annual Percentage Change] respectively) with similar patterns for men and women ages 20-29 (1.7 and 1.1 %), 30-39 years (3.4 and 3.0%)"

An Australian paper reported, "A significant increasing incidence in glioblastoma multiforme (GBM) was observed in the study period (annual percentage change

[APC], 2.5; 95% confidence interval [CI], 0.4-4.6, n = 2275), particularly after 2006." M. Dobes, B. Shadbolt, V.G. Khurana, S. Jain, S.F. Smith, R. Smee, et al., A multicenter study of primary brain tumour incidence in Australia (2000-2008), Neuro Oncology 13 (2011) 783-790.

In a recent paper reviewing all the evidence on incidence rates, Hardell concluded "that one should be careful using incidence data to dismiss results in analytical epidemiology." Hardell, Carlberg, Hansson Mild, Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma, Pathophysiology, accepted 15 November 2012. A copy of this paper is attached as Exhibit E

Q. Are there any safety standards or guidelines governing RF devices in the United States that are designed to protect people from non-thermal effects of RF exposure?

A. **No.** Safety standards or guidelines governing RF devices do not protect people from the myriad of non-thermal (no measureable temperature change) findings of adverse health effects from RF radiation devices. The "safety" standards are based only on immediate (acute) effects from excess heat averaged over 30 minutes. Long-term (chronic) effects from heating are not considered. The "safety" standards do not address peak-power effects. Yet during the evolution of today's standard the American National Standards Institute (ANS) stated, "It was recognized that the specific absorption rate (SAR), which provides the basis for limiting power densities, *does not contain all of the factors that could be of importance in establishing safe limits of exposure.* First, other characteristics of an incident field such as *modulation frequency* and *peak intensity* may pose a risk to health" [*emphasis* added] (ANSI, 1982, p. 14)."

There is a large body of scientific literature which has found adverse effects from non-thermal (no measurable change in temperature) exposure to electromagnetic fields (ELF and RF). The FCC guidelines also do not adequately consider the greater exposure risks for children or for particularly susceptible organs like the eyes and testes. *See* Om Gandhi, et al., Exposure Limits: The underestimation of absorbed cell phone radiation, especially in children, Electromagnetic Biology and Medicine, March 2012, Vol. 31, No. 1. A comprehensive review of low-level RF effects on reproductive processes 1s provided in the Bioinitiative Report, 2012, Section 18. The Introduction to Section 18 states, "This review presents evidence for ELF-EMF and RFR effects on many parameters of male sperm function; leading to questions about the genotoxicity and carcinogenicity of such exposures on fertility and reproduction in men."

Q. Do you agree with the Exponent witnesses' assertions that RF exposures from smart meters are many times less intense than from cell phones?

A. The table provided in the Exponent testimony (p 5) is based on *average* power densities. What is important is the peak-power density. As an example of why peak-power, not average power, is what matters: If a bullet is shot through your head in a thousandth of a second, the bullet's impact averaged out over a longer period, say 30 minutes, would likely suggest that little or no harm was caused. Elsewhere in their testimony, Exponent witnesses admit that "the peak power of a CMP Smart Meter is similar to a mobile phone." Exponent, p 32.

Q. The Exponent witnesses testified that: "The assessment of a health risk from any source is tied to the level of exposure, so that for any effect caused by a high level of exposure, lesser effects or no effect are anticipated at low levels of exposure." Do you agree with this assertion?

A. **This is the scientific principle of dose-response. The principle does not always apply.** Here, Exponent is arguing that if health risks are not identified by research on the higher RF exposure from mobile phones, then health risks are particularly unlikely with the considerably lower exposure associated with Smart Meters." First, **they assume Smart Meters result is a "considerably lower exposure" than other sources, but as they have stated, the peak-power density from a smart meter is comparable to other exposures including cell phones.** Second, while the principle may apply to chemical toxicology it does not necessarily apply to electromagnetic radiation (EMR) exposure. Biological effects from EMR exposures have been found to interact with the vectors of the earth's static magnetic field and EMR. **There are window effects where differing effects are found within different frequency and exposure ranges. There are threshold effects where an effect is only seen above an exposure; there are resonance effects that only occur within a small range of frequencies; and there are interactive-resonance effects where the effect is only seen with a small range of frequencies interacting with the vector of a static field** (e.g., Earth's magnetic field) and the vector of a dynamic field. (Emphasis added.)

Q. Are you aware of any studies demonstrating with any degree of certainty that exposure to radio frequency waves in or near the 2.4 GHz range is safe?

A. **No, but many studies report adverse health effects from exposure to microwave radiation, including some in the 2.4GHz range.** It is important to understand that the specific carrier frequency, 2.4 GHz in this case, is relatively unimportant. What is very important is the modulation of the carrier frequency. For example, in the EU' s REFLEX studies of human cells they found that the threshold for genotoxic (damage DNA) effects on human fibroblast cells from exposure to

2nd generation (G2) cellphone modulation (GSM) was a specific absorption rate (SAR) of 0.30 W/kg (GSM Effects: Risk Evaluation of Potential Environmental Hazards From Low Frequency Electromagnetic Field Exposure Using Sensitive in vitro Methods, QLK4-CT-1999-01574 / REFLEX / Final Report, Figure 94, page 128), In contrast a similar genotoxic effect from 3rd generation cellphone modulation (UMTS) was found at a SAR=0.05 W/kg (the FCC SAR limit is 1.6 W/kg). In other words, the threshold for damaged DNA in human fibroblast cells is 6 times lower from G3 modulation compared to G2 modulation. (UMTS Effects: Schwarz et al. Radiofrequency electromagnetic fields (UMTS, 1,950 MHz) induce genotoxic effects in vitro in human fibroblasts but not in lymphocytes. Int Arch Occup Environ Health (2008) 81:755-767). **Like cell phones, smart meters radiate sharp pulses or bursts of modulated carrier frequency waves.**

Q. Is there evidence of adverse biological effects associated with low-level RF at intensities in the range of 0.4 m W/cm^2 or less?

A. **Yes, there are many studies reporting biological effects at very low levels of power density. Attached as Exhibit F is a partial list of human studies showing adverse effects with average levels of power density exposure below the average level expected from a smart meter.** (Emphasis added.)

In addition to the recommendations made in the Biointiative Report, 2012, many scientists, who are among the most qualified experts in this field, have concluded that precautions should be taken to avoid exposure to very low-level modulated RF. See the following documents attached as Exhibits G-J:

Fragopoulou et al, Scientific panel on electromagnetic field health risks: consensus points, recommendations, and rationales. Rev Environ Health. 2010 Oct-Dec;25(4):307-17 (Ex. G, reporting evidence of adverse health effects as low as 0.0085 m W/cm^2);

The London Resolution (Ex. H, calling on the ICNIRP to reassess exposure guidelines and for use of precautionary measures in the use of RF devices);

The Porto Alegre Resolution (Ex. I, recommending the use of precautionary measures in the use of RF devices and stating that ICNIRP and IEEE/ICES standards "are being supported and promoted by interested parties");

and The Venice Resolution (Ex. J, recognizing the growing public health problem of electrohypersensitivity and calling for precautionary measures and the development of new standards).

There are also many highly knowledgeable public policy experts and physicians who make similar recommendations. See the following documents attached as Exhibits K - P:

2011 European Environment Agency Statement on Mobile Phones and the Potential Head cancer risk for the EMF Hearing on EMF (Ex. K, making the case that **a proper and transparent consideration of the strength of the evidence, consistent with Bradford Hill's paper,[7] requires the use of precautionary actions to reduce exposures to RF**); (Emphasis added.)

2012 Institute for Health and the Environment, Smart Meters: Correcting the Gross Misinformation (Ex. L, **calling for correction of misinformation by industry-funded studies and for precautionary measures be followed including the use of wired smart meters instead of RF emitting smart meters**; (Emphasis added.)

January 19, 2012 letter from the American Academy of Environmental Medicine (Ex. M, opposing the installation of wireless smart meters);

International Doctors' Appeal (Ex. N, physicians demanding use of precaution to avoid health risks of RF);

Consensus paper of the Austrian Medical Association's EMF Working Group (Ex. 0, Austrian Medical Association guideline for the diagnosis and treatment of EMF-related health problems and illnesses).

Resolution 815 (20 11) Resolution of Parliamentary Assembly of the Council of Europe (Ex. P, recommending "ALARA (as low as reasonably achievable) principle is applied, covering both the so-called thermal effects and the athermic or biological effects of electromagnetic emissions or
radiation.")

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[7] Bradford-Hill A. The environment and disease: Association or causation? *Proc R Soc Med 1965;58:295-300.*

Q. Have you reviewed the report issued by Exponent dated September 19, 2012 and titled Measurement Validation of Exposure Predictions from the Central Maine Power Smart Meter Network?

A. Yes.

Q. Have you also reviewed the Exponent testimony dated November 16, 2010 and portions of Dr. Shkolnikov's testimony at the November 9, 2012 technical conference?

A. Yes. I reviewed the November 16, 2010 and the November 9 testimony pertaining to Exponent's calculations and measurements of power density values.

Q. Do you have specific observations about or reactions to the 2010 testimony Exponent testimony?

A. Yes, there are a number of statements that require comment.

I note that Dr. Erdreich states she is a member of the ICES Standards Coordinating Committee that has developed exposure standards for EMF. Dr. Bailey also testified that he is a member of Subcommittee 4, Safety Levels with Respect to Human Exposure to Radio frequency Fields (3 kilohertz [kHz] to 3 GHz) of ICES. **This would mean that both of these industry paid expert witnesses were likely involved in the creation and/or maintenance of the IEEE Std C95.1 1991 standard. This standard was adopted by the FCC in 1996 and remains the FCC exposure limit to this day. The chair of the IEEE ICES Committee throughout the length of its creation was C-K Chou, a Motorola Executive. This serves to demonstrate how pervasive industry's influence is and how the industry influences the standard-setting process.** (Underlining and emphasis added.)

On page 19 Exponent puts a spin on the FCC RF standard by saying it "uses a 50-fold reduction factor below an effect level reported in research studies to arrive at an exposure limit for all members of the general public." In fact, the reduction factor for the general public is 2.5, not 50. They arrived at this 50-fold reduction factor because they asserted that hungry rats stopped looking for food at a whole body SAR of 4 W/kg. This was reduced 10-fold to 0.4 W/kg. Then considering exposure to the general public should be lower that electrical worker whose exposure is "concomitant to their employment," the general public's
exposure was reduced 5-fold to a whole body SAR of 0.08 W/kg. This is how they arrived at 50-fold reduction.

In fact the hungry rats stopped looking for food at whole body SAR of 1 W/kg, and at 4 W/kg the cessation of eating when hungry was "tantamount to an irreversible effect." Thus it was not a 10 fold reduction it was a 2.5-fold reduction. The 5-fold reduction for the general public does not exist. As these
exposure limits are averaged over time, the general public's averaging time is 30 minutes and the electrical workers averaging time is 6 minutes (5-fold less than the general public's time). Reducing the whole body SAR by 5 then increasing the average time by 5, results in no reduction whatsoever. It is important to note that the ICNIRP standard recognized this nonsense. ICNIRP's averaging time is 6 minutes for both the general publics and for electrical workers.

On Page 19, **Exponent suggests that the FCC standards are designed to protect children and other sensitive persons. Nothing could be further from the truth. Children have been shown in multiple studies, including industry studies** (Wiart et al, Exhibit B, 46), **to absorb more than double the microwave radiation when compared to adults. The existing standard does not incorporate this information.** (Emphasis added.)

On page 23, **Exponent claims that the FCC standard is based on a review of every relevant published study and that "in its 2005 update of C95.1, IEEE listed over 1,000 published papers that it referenced in its weight-of-evidence rationale for developing the standard. In fact, IEEE uses a database that excludes many studies showing adverse health effects, and there have been a large number of studies since 2005 with no reconsideration of the standard.** Figure 2 (page 27), shows that the FCC exposure limit is exceeded with a 10% duty cycle at less than 2 inches. Based on this data, CMP should place a warning on all smart meters not to come closer than 2 inches from the meter. (Underlining and emphasis added.)

On page 37, **Exponent claims that "Smart Meters do not produce pulsed radio frequency electromagnetic fields." This is untrue. The nature of any digital signal is it is a pulsed, modulated signal.** (Underlining and emphasis added.)

On page 40, Exponent claims: "The WHO established the International EMF Project in 1996 to coordinate research funding and assess the scientific evidence of possible health effects of EMF in the frequency range that includes RF (http://www.who.int/peh-emf/en/)." It was not WHO, who founded the International EMF Project it was Michael Repacholi, the founder of ICNIRP, who founded it. WHO's only role was to allow it (probably because the International EMF project received its funding from industry and WHO's funding was not required).

On page 43, Exponent claims: "Studies of a specific technology are not essential for determining possible health effects from its use." This is true to a point. However there is clear evidence that one type of modulation of carrier frequency cause adverse effects and a different modulation create adverse at a 6- fold lower level of radiation (see EU's REFLEX studies, p. 20 supra). **It is essential that health effects should be tested before any new RF radiation modulation technique is introduced into our environment. As is, the largest health experiment ever performed is now underway without the informed consent of the experiment's subjects**. (Underlining and emphasis added.)

On page 48, Exponent acknowledges that "manufacturers of pacemakers and implantable cardioverter-defibrillators (lCD) recommend a minimum distance of 6 inches from mobile communication devices." CMP should be required to post a warning on all smart meters that a person with such medical equipment
devices should keep a defined distance from the smart meter. The warning should be in sufficiently large type that it can be read from the defined distance.

Q. Do you have specific observations about or reactions to the September 19, 2012 report titled Measurement Validation of Exposure Predictions from the Central Maine Power Smart Meter Network, and Dr. Shkolnikov's testimony at the technical conference?

A. Yes, again there are a number of statements that require comment.

They state that the purpose of the study was to validate the predicted or calculated value they gave in their 2010 testimony, which was an averaged "typical" power density value of 0.000015 mW/cm^2 (15 nW/cm^2) at 1 yard. Yet, they used a measuring device (Narda NBM-550) that they report as being incapable of measuring RF signals below 170 nW/cm^2 However, the NBM-550 manual states that the measurement range can be set with a minimum of 2.5 nW/cm^2 (see Narda manual, page 51; ODR 1-09 p. 59). Either Exponent chose an instrument incapable of measuring the value they sought to validate, or the instrument was capable of measuring the value to be validated, but they set the measurement range too high to measure and validate the value. They fitted the Narda NBM-550 with the EF1891 3MHz-18GHz E Field (Flat) Probe. This means that all measurement would be across a very large bandwidth, 0.003 to 18 GHz.
However the frequency range of interest was a narrow range of 2.4000-2.4835 GHz (total range 0.0835 GHz and 0.46% of range this Narda meter). In effect, every measurement made was where 99.5% of the signals "seen" by the meter were not from the smart meter. If signals were outside the bandwidth of the smart meter's bandwidth were very low in relation to the signals within the bandwidth of the smart meter, then there would be considerable underestimation of the strength of the smart meter's signals.

They brought a Selective Radiation Meter SRM-3006 that clearly had the capability of measuring 15 nW/cm^2 but they chose not to use it for that purpose. It also had the capacity to measure peak values, but they chose not to use it for that purpose either. They provided a calculated peak value in their 2010 testimony, but chose not to attempt a validation of that figure despite the fact that peak values are more relevant to non-thermal biological effects from low-level RF radiation. A spectrum analyzer is a very flexible measurement tool. It can measure peak or average. It can measure these with a defined spectrum or at specific frequencies or both.

Most importantly a spectrum analyzer has a "trigger mode" where it would capture a signal a defined signal if detected. This is of critical importance because the smart meters with their low duty cycle transmit randomly in time so without a trigger it would be nearly impossible to capture a signal when it occurs. In should be possible to trigger on all signals within the 30 minute averaging period, except that such signal would most likely not be distinguished from other ISM8 band devices.

It appears that Exponent chose its equipment and designed its study to avoid capturing any smart meter packet transmission, and it appears that they succeeded.

Dr. Shkolnikov attempts to explain Exponent's lack of interest in peak values by claiming that peak values do not relate to any standards (11/9/12 Tr. p. 39). This is simply not true. There are many standards that consider peak values, including the FCC RF standards.

They emphasize that their predicted "typical" duty cycle of 0.05% represents only 43 seconds of transmission during the day. They don't mention that 43 seconds represents approximately 10,094 transmissions of RF radiation, assuming each transmissions lasts "at most 4.26 milliseconds." Report, p.6. At page 11 of the Report, they state that the worst case scenario would involve a smart meter with 4,998 descendants. With 34 packets per day per smart meter, that results in 169,966 bursts of modulated RF transmissions in one day (4998 x 34 plus 34). And this number does not include the additional "retransmit packets" that occur whenever a transmission fails. Report, p. 5. Such "failed" transmissions are likely caused by interference from Wi-Fi or other ICM band signals.

They report that: "Since the CMP Smart Meter network is dynamically configured, **the communication load on any specific Smart Meter can vary from day to day**." Report, p. 10. For this reason and **for good public policy designed to ensure the safety of all utility customers, the only level of exposure relevant to the Commission's investigation is the worst case scenario exposure**—the cumulative effect of daily exposures from more than 169,966 bursts of modulated RF transmissions. (Underlining and emphasis added.)

Q. In your opinion, could a careful scientist familiar with the body of knowledge on the subject reliably conclude that there is no evidence of, and no risk of, non-thermal adverse effects from exposure to RF in the range of 2.4 GHz at levels of intensity associated with smart meters?

A. **No on the contrary, careful scientists familiar with the body of knowledge on the subject would conclude that *there is* substantial evidence of risk from exposure to RF in the microwave range which includes 2.4 GHz.** (Emphasis added.)

The sheer numbers of people who have experienced electromagnetic hypersensitivity symptoms after exposure to smart meters should be enough for public policy makers to determine there is a serious health risk. Even if smart meter emissions did not emit enough radiation to be the sole cause of adverse health effects, the additive effect of their emissions on top of other RF emissions already in our environment can easily cause adverse health effects over time especially with the daily exposure in the home environment. To wait for further proof is to engage in a very dangerous and unethical experiment on millions of human subjects with potentially huge humanitarian and economic consequences. (Emphasis added.)

[Morgan testimony - End quote]

EXHIBIT 1I (FD):
Qualifications and Direct Testimony of David O. Carpenter, M.D., given before the Michigan Public Service Commission, Case No. U-15768.
https://ehtrust.org/wp-content/uploads/testimony-of-dr-david-carpenter-with-exhibits.pdf

Dr. David O. Carpenter, MD, is a Harvard Medical School-trained physician and Professor of Environmental Health Sciences. He is the Director of the Institute for Health and Environment, University at Albany School of Public Health (State University of New York) where he previously served as Dean of the School of Public Health. He is a co-editor of the landmark *BioInitiative Report* which documents the enormous body of peer-reviewed, scientific research on biological effects of non-ionizing radiation as well as the effects of low frequency radiation and electromagnetic fields produced in the operation of electrical circuits and power lines. Dr. Carpenter's curriculum vitae and long list of research papers and other publications appear on pp. 24-53 of Carpenter Exhibit Two following his testimony. Dr. Carpenter's testimony specifically concerning AMI smart meters reads in part:

[Carpenter Testimony - Begin quote]

Q. Do you swear that the testimony you are about to give is the truth, the whole truth, and nothing but the truth?

A. I do.
...
Q. Are you also associated with the Institute for Health and the Environment at the University at Albany, State University of New York?

A. Yes.

Q. Could you tell us briefly what is the scope of research done there and what is your role at this institute?

A. I am the Director of the Institute for Health and the Environment, a Collaborating Centre of the World Health Organization. The Institute promotes interdisciplinary research on issues relating to both health and the environment in both domestic and international settings.

Q. Have you devoted a substantial part of your career to studying the effects of low-level non- ionizing radiation upon human beings?

A. Yes.

Q. Do you understand the purpose of this administrative law case and why we have asked you to contribute your testimony?

A. Yes ... I understand the Court of Appeals has directed the Commission to consider the "risks and burdens" of AMI technology, as well as its presumed benefits ... .

Q. Do you have an opinion, based on your professional knowledge and experience, as to **whether the widespread deployment of radio transmitting smart meters is a safe and prudent course of action, given the present state of knowledge concerning the effects of such radio transmissions upon biological processes**?

A. I do. **My belief is that such widespread deployment cannot be justified at this time based on the peer-reviewed research we have. I would say that universal deployment of such meters throughout our urban areas amount to an experiment on the people living in those areas, an experiment without the consent of the experimental subjects**.

Q. Can you substantiate that point?

A. Yes. Earlier this year I was asked to write my concerns about the health hazards of smart meters. **Forty-five medical professionals and scientists, who together have authored hundreds of peer-reviewed articles on the effects of electromagnetic radiation, joined together with me in a statement expressing our views on the effects of low level radio frequency and microwave radiation in general and smart meter radiation in particular**. That statement is attached to my testimony as Exhibit One.

Q. And can you tell us briefly what conclusions were expressed?

A. While smart meters are too new for there to be human health studies specifically on exposure from smart meters, **there is a strong body of evidence that demonstrates a variety of adverse human health effects, including cancer and effects on brain and behavior, coming from exposure to radiofrequency radiation like that generated by wireless smart meters**.

Q. To the best of your knowledge, what percentage of the general public could be called "electro-sensitive", i.e., people who experience more or less immediate symptoms when exposed to electromagnetic radiation, such as headaches, mental confusion, rapid heartbeat and so on?

A. While the evidence is incomplete for several reasons, most reports indicate that between 5 and 10% of the population show symptoms of electrical hypersensitivity.

Q. **Is it possible that electro-sensitive people are like the canary in the mine? Or, more precisely, is it possible that the kind of electromagnetic fields that cause electro-sensitive people to experience immediate symptoms of distress, are also the kind of fields that are likely to cause long term illness to a much larger group of individuals who do not experience immediate symptoms**?

A. **Yes, this is not only possible but likely**.

Q. **So would it be fair to say that from a public health standpoint, protecting the most vulnerable among us might well be viewed not only as an act of compassion toward them but also have the effect of protecting the majority of the population from long term diseases like cancer or neurological diseases like Alzheimer's Disease?**

A. **This is true**.

Q. Is there data on smart meters going back far enough to trace the long term effects of such meters on people?

A. No, but until more data becomes available **we have to make inferences based on longer term data that we do have concerning use of cell phones and people living near to radio transmission towers. These studies show that increased radiofrequency exposure increases risk of cancer, and that the most vulnerable parts of the population are children and teenagers**.

Q. Have you had occasion testify previously about such effects?

A. Yes, in January, 2012, I testified concerning the effects of WiFi radiation on school children in the Oregon Public Schools. My legal testimony in that case is attached here as Exhibit Two.

Q. Can you give us a very brief summation in a few sentences as to your conclusions about the Wi-Fi study?

A. As with wireless smart meters, WiFi in schools exposes children constantly to radiofrequency radiation. As with smart meters, the specific health effects from exposure to WiFi have not been determined, but WiFi is radiofrequency radiation. Because children are more vulnerable than adults to raidofrequency radiation, as documented by studies from cell phone use and people living near to radio transmission towers, it is unwise to use WiFi in schools when a wired connection to the internet does not increase exposure.

Q. **Does an opt-out plan really solve the exposure risk** you have been describing here and in your exhibits?

A. **Not entirely. Not having a smart meter on one's own home will reduce the potentially harmful exposure, but the customer opting out is still going to be exposed to a whole blanket of electromagnetic radiation from the smart meters of immediate neighbors and from all the transmitting and receiving devices and repeaters the utility must install to allow all these meters to report their data**, as well as other sources of radiofrequency radiation.

...

Q. Is there anything else you would like to add to your testimony today?

A. **Exposure to radiofrequency radiation has been shown to result in human disease, and we should take every step within reason to avoid increased exposure**. ... **But at the very least everyone should have the opportunity to opt-out of having wireless smart meters placed on their home**. (Underlining and emphasis added.)

[Carpenter Testimony - End quote]

EXHIBIT 1J-1 (FD):

Direct Testimony and Exhibits of Professor Martin Blank, PhD, Department of Physiology and Cellular Biophysics College of Physicians and Surgeons, Columbia University. Testimony of Dr. Blank was given before the State Corporation Commission of the Commonwealth of Virginia, Case No. PUE 2009-00043.

http://www.stoppathwv.com/documents/blank-testimony.pdf

Dr. Blank had taught and conducted research at Columbia for over 45 years. His primary responsibility had been to conduct research, and he had "specialized in the effects of EMF on cell biochemistry and cell membrane function." His most recent research was on "health related effects of electromagnetic fields (EMF), primarily on stress protein synthesis and enzyme function." In his testimony and exhibits on EMFs, Dr. Blank points to a "wide range of biological systems affected, the low response thresholds, the possibility of cumulative effects by repetitive stimulation and the inadequacy of exposure standards." Further reference to Dr. Blank's educational and professional background and eminent career appear on page 2, and his curriculum vitae, including a listing of his prodigious number of books, published papers and research is included in 'Blank Exhibit A' following his full testimony in the pdf file (FD). His testimony reads in part:

[Blank testimony I - Begin quote]

Q: What is the purpose of your testimony?

Ans: The aim of my testimony is to discuss the medical and biological effects of exposure to EMF, and to show the scientific basis of our understanding of the health risks arising from exposure to the EMF ... . Research on the biological processes affected by EMF and their consequences to human health has increased our understanding of biological mechanisms and underscored the need for greater protection of populations exposed to EMF, especially young children.
...
I shall discuss published reports, primarily peer-reviewed epidemiological and laboratory studies, including my own research to show that:

- EMF affects many fundamental biochemical reactions in cells at field strengths in the range of observed epidemiology thresholds.

- Low levels of EMF stimulate stress protein synthesis (‘**the stress response’**), a protective cellular mechanism that is activated by such established harmful stimuli as high temperature and acidity. **Activation of the stress response by low levels of EMF indicates that cells react to EMF as potentially harmful.**

- Since the code for synthesizing proteins is in the DNA structure, initiation of stress protein synthesis indicates that EMF interact with DNA. At relatively low intensities, EMF lead to DNA chain separation and protein synthesis. At higher intensities, EMF has been shown to damage DNA by causing strand breaks.

- It is generally agreed that cancer is associated with DNA damage (mutations). The

link between EMF and DNA damage is seen in a study where children missing DNA repair genes have a much greater incidence of leukemia on exposure to EMF. This suggests that an inability to repair DNA damage caused by EMF can predispose a child to leukemia.

- EMF have also been associated with harmful biological effects in adults. EMF inhibit the secretion of melatonin which normally inhibits oxidation damage. Human breast cancer cells have been shown to grow faster in EMF, probably because of enhanced oxidation damage. EMF is also associated with an increase in the incidence of Alzheimer's disease and senile dementia, both of which increase linearly with the duration of EMF exposure. The large database of the study and the demonstrated dose-response of the data strengthen the reliability of the results, which described effects at relatively low EMF ... .

- There are plausible molecular mechanisms to account for the observed biological effects of low-level EMF. Biochemical studies have shown that EMF can accelerate electron transfer reactions, that electrons can be displaced in DNA, and that the resulting charging can cause DNA disaggregation. The physical properties (electron affinity, fluorescence depolarization) of particular bases (CTCT groups) in segments of DNA activated by EMF appear to contribute to these interactions.

  In the past, EMF safety issues only considered the need to protect against acute large effects, such as electric shock, while chronic low level exposures were believed to be without consequence to health. Recent research has shown potentially harmful effects associated with chronic low level EMF ... . Weak EMF pass easily into cells and constitute a significant risk, especially to children ... .

  Q: Are living cells unusually sensitive to EMF (magnetic fields)?

  Ans. ... Even weak EMF constitute a significant risk to living cells, especially to the rapidly growing cells in children. Low EMF thresholds in several biological systems have been published in peer-reviewed journals ... . The measured thresholds for changes in enzyme activity and in biosynthesis of stress proteins are in the range of the epidemiology threshold.
  ...
  The stress response is a reaction to potentially harmful agents, such as high temperature, acidity, toxic metals, alcohol, etc, that leads to stimulation of DNA and the synthesis of stress proteins. Stimulation of the stress response by EMF shows that cells react to relatively low EMF levels as potentially harmful. EMF blockage of the inhibition of breast cancer cell growth by melatonin may be a significant factor in the mechanism of the disease.

  Q: Please comment on the very high safety level set by ICNIRP.

Ans. ... ICNIRP interpret EMF safety as prevention of acute large effects, such as electric shock ... . They believe that low level exposures, that they call non-thermal, do not cause biological effects and are without consequence to health. They may no longer be able to ignore the data showing that many fundamental biological processes are activated by low level EMF. The Parliament of the European Union voted in September 2008 to re-examine and readjust safety levels on the basis of measured biological effects. Activation of the stress response is certainly indicative of protective cellular responses to low level EMF.

Q: Describe the biological effects of EMF from your research on the stress response.

Ans. In 1994, my colleagues and I were the first to show that 60Hz EMF can activate the stress response, i.e., stimulate the synthesis of stress proteins, at low field strengths (reviewed in Goodman and Blank, Cell Stress and Chaperones 3:79-88, 2001). This observation has now been confirmed many times, in the RF as well as ELF ranges, and the research has provided insight into the biological mechanisms of EMF interactions. Following are some important conclusions based on this research:

- The stress response is a cellular reaction to potentially harmful environmental stimuli. The response should be seen as essentially the testimony of cells, in their own language, that EMF is potentially harmful.

- Activation in the non-thermal (i.e. low energy) ELF range as well as in the thermal RF range clearly indicates that non-thermal stimuli can activate biological effects similar to those activated by thermal stimuli. These data indicate the need to incorporate non- thermal biological effects in the evaluation of health risk and to revise recommended safe levels.

- The SAR, or specific absorption rate, is a measure of energy input that is used to estimate exposure at higher EMF frequencies. However, it is obviously unrelated to biological thresholds and cannot serve as a measure of biological safety. The SAR should be replaced by a measure of biological function for purposes of risk assessment.

- Molecular studies of stress proteins have enabled us to determine the DNA segments that respond to EMF. We have transferred EMF responsive segments to artificial DNA constructs and activated other genes using EMF (Lin et al, J Cell Biochem 81:143-148, 2001). Columbia University holds the patent for this use of EMF responsive DNA as a magnetic trigger.

- The EMF responsive segments of DNA contain CTCT bases. The physical properties of the CTCT bases suggest a molecular mechanism for reacting to EMF and causing chain separation. The molecular insights from the research, together with related research on protein disaggregation reactions, have enabled us to account for stimulation of DNA by **relatively weak, environmental level EMF**. A plausible molecular mechanism has been proposed (Blank, Electromagnetic Biology and Medicine 27:3, 2008). See generally, Blank & Goodman, Electromagnetic fields stress living cells, Pathophysiology 16 (2009) 71-78. Exhibit D.

Q: Is there a plausible biological mechanism to link EMF with cancer?

Ans. Cancer is generally believed to result from DNA damage (mutations), and it is the ability of EMF to cause DNA damage by various mechanisms that suggests it as a possible cause. Cancer is actually many diseases and they generally take many years to develop. Childhood leukemia is atypical in appearing after only a few years, but children grow rapidly with active metabolisms that accentuate the molecular damage during protein and DNA synthesis as cells grow and divide. Natural repair mechanisms correct the errors that occur during normal growth, but they never correct 100% and in protein synthesis, at least one molecule is damaged for every billion made. The errors build up and eventually damage a cell to the point where it cannot function properly.

For a long time it was thought that weak EMF do not have sufficient energy to activate, let alone damage, such large molecules as DNA. However, the stress response has shown activation at very low levels and DNA single strand breaks ... have shown the damage is possible. We now know that the charging of macromolecular complexes can lead to their disaggregation (Klug, Nobel lectures, 1982; Blank and Soo, Bioelectrochem Bioenerg 17:349- 360.1987), and play a key role in membrane transport proteins, including ion channels. It is therefore possible for weak EMF to cause electron movements in DNA that redistribute charges and trigger large molecular rearrangements, e.g. DNA splitting. A possible sequence of steps may start with EMF displacing electrons and charging DNA segments, followed by disaggregation of DNA strands as a result of the charging.

... We know that at higher field strengths and higher frequencies, EMF can cause dose dependent, single and double strand breaks in DNA (Lai and Singh, Bioelectromagnetics 18:156-165, 1997; and others in the online REFLEX Report, 2005).

Q: Has EMF been linked to diseases other than leukemia?

Ans. EMF exposures have been shown to modify the tumor suppressing action of melatonin, an important natural secretion of the pineal gland in the brain that affects many natural processes, including sleep (Liburdy et al. J Pineal Res 14:89-97, 1993). Studies replicated in several labs show that low level EMF blocks the growth-inhibiting action of melatonin on human estrogen receptor-positive, breast cancer cells, as well as the near-complete blockage of the anticancer (chemotherapeutic) drug Tamoxifen. ...

...

There are currently many studies of tumors in the head (gliomas, acoustic neuroma, parotid gland tumors) correlated with the use of cellphones. These are generally discussed in terms of the radio frequency EMF that carries the cellphone signals, although there are low frequency components (12Hz, 217Hz) associated with the transmission that could be involved in interactions with DNA. (Emphasis added.)

A recent study of the incidence of cancer in school teachers related the abnormally high incidence (odds ratio, OR = 9.8 vs expected OR = 2.78) to the radiofrequency noise on the 60Hz AC lines in the schoolrooms used by the teachers over a period of years. (Milham, Morgan Am. J. Ind. Med. 51:579-586, 2008). **The unusually high cancer incidence was strongly associated with high frequency voltage transients**, and it was suggested that this EMF may be a carcinogen similar to ionizing radiation. The data indicated that a single year of employment at this school increased a teacher's cancer risk by 21%. (Underlining and emphasis added.)

The increasing frequency of reports of the association of diseases with EMF exposure along with a growing understanding of plausible mechanisms that involve changes in DNA have given greater credence to the links between EMF and disease. ...

Q: Is the 3-4mG level of EMF a 'safe' level?

Ans: ...There is no question that recent research has shown potentially harmful biological effects at low level EMF exposures for extended periods of time, and there is a need to reconsider EMF safety, as well as the 3-4mG level.

Q: How extensive is the health risk due to EMF levels near power lines?

Ans. ...There are related EMF issues that undoubtedly contribute to adverse biological effects.

- There is evidence that the radiofrequency RF 'noise' that accompanies a 60Hz signal (and that may become a feature of transmission lines with the addition of broadband) may cause such harmful effects as cancer and diabetes (Milham,

Morgan, Am. J. Ind. Med. 51:579-586, 2008). A desirable optimal design would aim for as 'clean' a 60Hz sine wave as possible.

...

Q: Please summarize your opinion of the health risk from EMF ...

Ans. ... Studies cited in my testimony indicate that even the weaker EMF beyond the ROW have the ability to cause significant changes in living cells by affecting fundamental biological processes, and predisposing them to the development of cancer and other diseases on prolonged exposures. It is therefore essential to minimize exposure of the population to EMF. While the errors in DNA that occur during cell division are most likely in rapidly growing children, recent research has shown that adults are also subject to the same risks on a somewhat longer timescale.

Q. Have you read the direct testimony of Mr. Alfred T. Ghiorzi on the health effects of EMF's?

Ans: Yes

Q. If you have formed an opinion on it, what is that opinion?

Ans: ... While there are many more studies on EMFs and their harmful effects, he has reported the growing concern among many scientists who are engaged in research on EMF due to growing evidence of significant biological effects with health implications that occur at low levels of exposure.

[Blank testimony I - End quote]

EXHIBIT 1J-2 (FD):
Testimony of Martin Blank, PhD, before the Board of Public Utilities, State of New Jersey, BPU Docket No. EM09010035.
https://legalectric.org/f/2009/07/testimony-of-dr-martin-blank.pdf

Reads in part:

[Blank testimony II - Begin quote]

...

- EMF affects many fundamental biological processes at field strengths in the range of observed epidemiological thresholds

- Low levels of EMF stimulate stress protein synthesis (the stress response), a protective cellular mechanism in reaction to such harmful stimuli as high

temperature and acidity. Activity of the stress response indicates that cells react to low levels of EMF as potentially harmful.

- It is clear that EMF leads to DNA chain separation, since initiation of stress protein synthesis requires the two strands of DNA to come apart. EMF interacts with DNA in the stress response at very low intensities, and can cause damage to DNA at higher intensities. EMF stimulation of DNA is important, because cancer is associated with changes in DNA called mutations.

- The relevance of DNA damage is seen in a study where children missing DNA repair genes have a much greater incidence of leukemia.

- EMF has also been associated with harmful biological effects in adults. EMF inhibits the secretion of melatonin which normally inhibits the growth of breast cancer cells, and breast cancer cells have been shown to grow faster in EMF. EMF also increases the incidence of Alzheimer's disease and senile dementia, the incidence increasing with the duration of EMF exposure.

- There are plausible molecular mechanisms to account for the observed biological effects of EMF. Biochemical studies have shown that EMF can accelerate electron transfer reactions and that electrons can be displaced in DNA. ...

  In the past, EMF safety issues only dealt with the need to protect against acute large EMF effects, such as electric shock of the firing of nerves, and not against chronic low level effects. Recent research, showing potentially harmful biological effects associated with chronic low level EMF, indicates the need for greater protection. We now know the even weak magnetic fields are biologically active. They easily pass into cells ... . For this reason, even weak EMF constitute a significant risk, especially to children ... .

...

Q.7. Do you have a particular perspective on research?

A.7. The various research and teaching roles I have assumed in my career have generally involved an interdisciplinary approach to complex problems. This has given me a broad perspective on scientific research and specifically in bioelectromagnetics. ...

...

Q.8. How do you see the role of science in determining EMF safety?

A.8. The need to base EMF safety standards on science is widely recognized. The IEEE guideline for revision of C95.1-1991 safety standards begins with that principle (*Bioelectromagnetics, Supplement 6*). Science is both a body of information and a method to obtain new information. Scientific research is

designed to answer questions, and 'scientific proof' is best understood in terms of the old meaning of 'proof' as 'test'. Scientific proof does not rely on 'weight of evidence', where one keeps a scoreboard of positive versus negative results and merely tallies the numbers. In scientific proof, number and weight do not count. It is the continuing accumulation of relevant data from all sources and the testing of scientific hypotheses regarding the biological effects of EMF that has provided useful information. It is in this way that scientific data from both epidemiology and laboratory studies continue to contribute to our understanding of the health risks associated with exposure to EMF. What started as an epidemiological link between EMF and childhood leukemia is now better understood in terms of EMF interactions with DNA. This current understanding of the scientific data underscores the need for greater protection from EMF exposure, especially for children.

...

Q.13. Please show EMF interaction with DNA helps in understanding the stress response and the possible link to cancer.

A.13. ... When there is a potentially harmful change in a cell's environment (a stress), stress proteins are synthesized. The stress response ... is used by all species in response to harmful environmental stimuli ... .

...

The response to EMF requires remarkably low energy input - over a trillion times lower than the thermal energy needed to evoke a response ... . (Underlining and emphasis added.)

...

Our laboratory was the first to report EMF stimulation of the stress response, and we identified EMF responsive regions with -CTCT- sequences in the promoter of the stress protein (hsp70). Inactivating these sequences by removal or mutation, eliminates the response to EMF. Inserting these sequences into an artificial construct containing a gene, causes the gene to be activated by EMF. ... Linkage of EMF responses with specific regions of DNA provides a non-invasive, precise technique for gene activation. Columbia University has a patent for this process based on our research.

Recent studies show that DNA conducts electrons along the bases within the double helix, and we have shown the EMF accelerate electron transfer reaction rates. ... The forces at low field strengths that affect enzyme reactions are large enough to move electrons in DNA and could lead to repulsive forces that cause chain separation.

[Blank testimony II - End quote]

EXHIBIT 13 (FD):
U.S. Congressional hearing testimony given by Dr. Ronald B. Herberman, MD, Dr. David O. Carpenter, MD, et al., on RF radiation exposure and cell phone usage. Dr. Herberman was Founding Director of the University of Pittsburgh Cancer Institute, professor of medicine, and an internationally recognized cancer biologist and tumor immunologist. Parts of Dr. Herberman's testimony are at 38:39, 53:54, 1:13:51, 1:38:58, and 1:57:24.

EXHIBIT 34A (FD):
Declaration by Martin Blank, PhD. Columbia University, January 28, 2016. Reads in part:

[Blank Declaration - Begin quote]

Based on a wide range of research studies, I conclude that:

• Electricity and magnetism are fundamental forces that interact with charged particles, i.e., primarily with electrons in our cells. The organism, in reaction to these conditions, produces **the cellular stress response, a DNA mechanism that is activated by many potentially harmful stimuli.** In other words, ***cells react to EMF as potentially harmful***.
...
• Stress protein synthesis starts with activation of DNA. **Higher RF-EMF levels can cause chemical changes in DNA that lead to mutations and cancer** and other abnormal biological processes (e.g., development and growth of tumors).

• **Biological systems are affected by a wide range of EMF frequencies, including ELF, RF and MW (microwave) ranges.** Because of the many sources in the environment (cell phone towers, WiFi, smart meters) the effects are additive. ... Unfortunately, the divisions of the EM (electromagnetic) spectrum were created by engineers and physicists who assumed arbitrary frequency boundaries that do not relate to the biology. **Human cells do not recognize EM spectrum divisions. They react to electromagnetic fields across the spectrum**.

• Furthermore, the same engineers and physicists assumed that the biological response was caused by the energy of the EMF stimulus, and could be measured by an increase in temperature. ***The biological response is stimulation of stress protein synthesis in DNA, and the stress response occurs across the EM spectrum*. When stress protein synthesis is stimulated by EMF, the body is essentially telling us that exposure is harmful to living cells.**

• ***The stress protein synthesis occurs*** **at field strength and duration thresholds that are very low and** ***below the temperature-based thresholds set by safety standards*****.**

...

However, the stress response has been ignored in the setting of safety standards. **Safety standards have been set based on the ability of EMF to heat tissue!** Both non-thermal and thermal EMF signals activate the stress response, ... but thresholds triggering stress on biological systems occur at levels on the order of ... **thousands of times lower energy than the 'safe levels' in the RF range.**

...

The stress response has provided vital evidence about cellular defense mechanisms – it shows that the reaction starts when EMF interacts with DNA.

...

The REFLEX Project, a collaboration of twelve laboratories in the European Union (Attachment 10 - REFLEX. 2004), found that **both ELF and RF exposures modified the expression of many genes and proteins well below the safety limits.**

For a long time, agencies such as ICNIRP (International Commission on non-Ionizing Radiation Protection) and WHO maintained that an EMF must increase the temperature in order to cause changes in cells. Many lines of research now point to changes in DNA without elevation of temperature. ... The effects occur in basic cellular systems at relatively low field strengths, similar to those in the environment. **Non-thermal ELF and RF fields can cause DNA damage, and therefore represent health and safety concerns**.

...

[O]ver 130 sources showing Radio Frequency radiation emitted by wireless transmitters has biological effects at levels millions of times lower than current FCC Safety Standards (see Attachment 22 Reported Biological Effects from RFR at Low-Intensity Exposure). **In addition to very low thresholds, exposure durations in the RF range do not have to be very long to be effective**. (Underlining and emphasis added.)

...

Litovitz et al (1991), working with the enzyme ornithine decarboxylase, have shown **a full response to EMF when cells were exposed for only 10 sec** (See Attachment 11)**.** This occurred with ELF sine waves or ELF modulated 915 MHz sine waves.

...

EMF have been shown to cause other potentially harmful biological effects, such as leakage of the blood brain barrier that can lead to damage of neurons in the brain, increased micronuclei (DNA fragments) in human blood lymphocytes, **all at exposures well below the limits in the current FCC guidelines in the US**. (Underlining and emphasis added.)

...
DNA can act as an antenna that is sensitive to many non-ionizing frequencies in the extremely low frequency (ELF) and radio frequency (RF) ranges.

The wide frequency range of interaction with EMF is the functional characteristic of a fractal antenna, and **DNA appears to possess the two structural characteristics of fractal antennas, electronic conduction and self symmetry. These properties contribute to greater reactivity of DNA with EMF in the environment, and the DNA damage could account for increases in cancer epidemiology** ... .
...
It is clear that the safety standards must be revised to take into account the potentially harmful non-thermal biological processes that occur.

[Blank Declaration - End quote)

EXHIBIT 29C-15 (FD):
The state of scientific research as to whether advanced meters transmitting by radiofrequencies, as proposed in the present case, may constitute a risk of serious or irreversible damage to health. Expert Report by David O. Carpenter. Régie de l'énergie / Quebec Energy Board - Docket no. R-3770-2011. April 30, 2012. Dr. Carpenter's expert report reads in part:

[Carpenter expert report - Begin quote]

I wish to stress that duration may be an even more potent contributing factor to RF/MW radiation bioeffects than exposure levels. Chronic, such as all-day exposure, is more likely than short and intermittent exposure, such as cell phone use, to produce harmful health effects. Although the exposure levels may be lower, the accumulated exposure over time has the potential to be greater and to cause greater harm.
...
It is generally accepted within the relevant scientific community and has been established beyond any reasonable doubt that adverse human health effects occur at far lower levels of RF/MW radiation exposure than those that cause measureable heating, particularly where the wavelength approaches body-part size and thus maximizes absorption, where the wavelength has resonance with the water molecule, where there is a more complex, modulated wave, where there is chronic exposure duration, and where exposed persons lack the capacity voluntarily to remove themselves from the radiation sources. ...

Some effects are known to occur at several hundred thousand times below the FCC public exposure guidelines and the similar guidelines of Health Canada's Safety Code no. 6 (of 6 000 000 $\mu W/m^2$ for the 902-928 MHz bandwidth) which are set based on the assumption, which we believe is incorrect, that there are no adverse health effects at exposures that do not cause easily measureable heating.

It is further to be noted that FCC guidelines also only apply to 30-minute public exposures and Health Canada's Safety Code no. 6 only applies to 6-minute public exposures; they are however being used to infer safety at durations >30 minutes (FCC) and durations >6 minutes (Health Canada's Safety Code no. 6).

Exposure to high-frequency RF and MW radiation have been linked to a variety of adverse health outcomes. Some of the many adverse effects reported to be associated with and/or caused by RF/MW radiation include cancer, neurologic, endocrine, immune, cardiac, reproductive and other effects.

Studies of isolated cells have shown that RF/MW exposures may cause changes in cell membrane function, cell communication, metabolism, activation of proto-oncogenes, and can trigger the production of stress proteins at exposure levels below the above FCC and Health Canada guidelines. Resulting effects in cellular studies include DNA breaks and chromosome aberrations, cell death including death of brain neurons, increased free radical production, activation of the endogenous opioid system, cell stress and premature aging.

Human studies of comparable RF/MW radiation parameters show changes in brain function including memory loss, retarded learning, performance impairment in children, headaches and neurodegenerative conditions, melatonin suppression and sleep disorders, fatigue, hormonal imbalances, immune dysregulation such as allergic and inflammatory responses, cardiac and blood pressure problems, genotoxic effects like miscarriage, cancers such as childhood and adult leukemia, childhood and adult brain tumors, and more.

There is consistent evidence for increased incidence of cancer and other adverse effects in individuals who live near to high-power short-wave, AM, FM and TV transmission towers. This is particularly relevant because, like WI-FI and smart meters, radio and TV transmission towers give continuous, whole-body radiation, not just radiation to the head.

In addition, it is to be noted that, should the 2,4 GHz ZigBee antennas of the proposed Hydro-Quebec Landis+Gyr meters be activated in the future, their wavelength, at ~ 12.2 cm or ~ 4.8 inches, would be more absorbable by children's and adults' bodies and brains than radio or TV wavelengths. The harmfulness of such radiation therefore likely exceeds that of radio or TV towers. The 2.4 GHz

frequency is similar to that used by a microwave oven. Such frequency was chosen for the oven because of its wavelength and harmonic resonance with the water molecule, to ensure the most efficient absorption by living tissues and effective heating by way of the agitation of water at the molecular level.

Like second-hand smoke, EMF and RF/MW radiation involve complex mixtures, where different frequencies, intensities, durations of exposure(s), modulation, waveforms and other factors are known to produce variable effects, often more harmful with greater complexity. Decades of scientific study have produced substantial evidence that EMF and RF/MW radiation may be considered neurotoxic, carcinogenic and genotoxic. Sources of fields and radiation include but are not limited to: power lines, navigational radar, cell phones, cordless phones [or Digitally Encoded Cordless Transmission Devices (D.E.C.T.) phones], cell towers, smart meters and their grids or infrastructure, "smart" boards, meters and grids, WiMax and wireless internet (WI-FI).

The RF/MW radiation and low-frequency EMF science that currently exists includes hundreds of studies dating back to the 1920s. On the basis of this vast body of literature, many public health experts, myself included, believe that it is likely society will face markedly increased incidence of neurotoxic effects, neurodegenerative diseases, cancers and genotoxicity in the future, resulting from the extreme and mostly involuntary exposure to RF/MW radiation and EMFs.

In public health science, it is generally accepted that vulnerable subgroups exist within any human population. This is also recognized specifically for RF/MW radiation and fields. These groups include children, pregnant women, the elderly, those with preexisting illnesses and/or impairments and some individuals who show electrical hypersensitivity. Children are more vulnerable to RF/MW radiation because of the susceptibility of their developing nervous systems. RF/MW radiation penetrates children's brains more than adult's because children's skulls are thinner, their brains smaller, and their brain tissue is more conductive than those of adults, and since it has a higher water content and ion concentrations. The Presidential Cancer Panel found that children .'are at special risk due to their smaller body mass and rapid physical development, both of which magnify their vulnerability to known carcinogens, including radiation.http://deainfo.nci.nih.gov/advisory/pcp/annualReports/pcp08-09rpt/PCP_Report_08-09_508.pdf. Furthermore, should the ZigBee antenna of the proposed Hydro-Quebec Landis+Gyr meters be activated, absorption of RF/MW energy in tissues of the head of children would even be greater due to the similarity between the wavelength at 2.4 GHz size and the children's head.

...

FCC public RF/MW radiation exposure guidelines (and the similar Health Canada Safety Code no. 6 guidelines) are based on the height, weight and stature of a 6-

foot tall man, not children or adults of smaller stature. The guidelines do not take into account the unique susceptibility of growing children to RF/MW radiation exposures. Since children are growing, their rate of cellular activity and division is more rapid, and they are at more risk for DNA damage and subsequent cancers. Growth and development of the central nervous system is still occurring well into the teenage years, such that the neurological impairments predictable by the extant science may have great impact upon development, cognition, learning, and behavior.

...

The evidence for harm from RF radiation as a cause of cancer and other diseases continues to grow. And when we focus on MW radiation, particularly pulse-modulated radiation, on long, non-intermittent duration and on more vulnerable subgroups such as children, we see that the cancer outcome is being firmly established.

...

Exposure thresholds for harmful effects are lowered in human populations and individuals when duration is increased.

...

As indicated above, the Quebec Energy Board has asked me to indicate if these research show that RF exposure *« may constitute a risk of serious or irreversible damage to health »*.

The above non-thermal biological effects do indeed constitute a risk [of] serious damage to health.

...

Standards setting organizations aimed at regulating RF exposure have for a long time been dominated by physicists and engineers, often with close ties with the industry, with few input from biological and medical science.

...

Both because of their training and because of their ties with the industry, members of most of these organizations have been reluctant to take the above biological findings into account into the exposure limits they set. At present, the exposure limits set by FCC and Health Canada as well as those set by various other standard setting organizations are based solely on biological effects resulting from heat.

...

Standards setting organizations have until now generally refused to accept epidemiological and laboratory research findings linking RF electromagnetic fields exposure with various non-thermal biological effects, as being inconclusive and requiring further research.

...

Standard setting organizations have so far however generally been reluctant to take into account these biological findings.

For instance, **the FCC-appointed guideline-setting Commission**, **ASTM-IEEE, in 1991 referred in its conclusions to RF/MW radiation, the Agent, as a** '**Hazard**,' specifically setting a '**Hazard Threshold**.'

It had however been discovered that, even amongst the 120 studies chosen by the Committee to prove the validity of its Hazard Threshold, there were 15 studies that concluded adverse effects at levels lower than the Hazard Threshold, thus disproving its validity. Three of these studies actually showed adverse effects at less than 10 percent of the Hazard Threshold. FCC did not take those into consideration when setting its guidelines.

Industry also largely controls the funding of research in this matter, which represents an additional difficulty.

[Carpenter expert report - End quote] (Paragraph numbers have been omitted.) (Emphasis added.)

EXHIBIT 45B (FD):
Amended Declaration of Dr. David O. Carpenter, MD, Director of the Institute for Health and Environment, University at Albany School of Public Health, State University of New York. (U.S. District Court Civil Action No. 3:11-cv-00739-MO, p. 8.). Reads in part:

"[E]ven as of 1990, the US Environmental Protection Agency ("EPA") had determined RF/MW radiation a 'probable carcinogen'. Now that we have much more confirming study in the interim, the conclusion is yet more certain. And when we focus on MW radiation, particularly pulse-modulated radiation, on long, non-intermittent duration and on more vulnerable subgroups such as children, we see that the cancer outcome is very certain, indeed. (Underlining and emphasis added.)

EXHIBIT 45H (FD):
Reply of Dr. David O. Carpenter, MD, to Dr. David Savitz, PhD. (U.S. District Court Civil Action No. 3:11-cv-00739-MO, p. 2.) Reproduced nearly in its entirety:

[Carpenter reply - Begin quote]

1. In this response I draw upon my over 30 years of extensive work in the research and review of electromagnetic fields and radiation, as well as my academic positions as Pubic Health Science Professor, Dean, Research Physician and Director, Fellow and Chair of various research institutes, with considerable

experience in evaluating epidemiology and toxicology. I draw also upon the scientific studies and reviews I have previously submitted and several more added herein.

2. This very large body of scientific literature has a long history of exploring and understanding interactions between EMF/RF and human health, including investigations that had begun more than fifty years ago in the United States alone. For example, the 1965 W. Bergman paper, *The Effect of Microwaves on the Human Nervous System*, stated, "The present study demonstrates that short electromagnetic waves can have an extensive influence on the central nervous system." (Underlining added.)

3. "This paper was influential toward the 1968 amendment to the US Public Health Service Act, wherein Subpart 3, Sec. 354, states, "**The Congress hereby declares that the public health and safety must be protected from the dangers of electronic product radiation**". The dangers had been established in both the science and public policy realms more than forty years ago. **Thousands of studies have been published since that time, and have demonstrated adverse effects from exposure to electromagnetic fields and radiation, including a number published by Dr. Savitz**. (Underlining and emphasis added.)

4. In this context, I would point out again that high quality positive findings, e.g., adverse effects associated with or caused by environmental toxics and physical agents, often outweigh negative findings, even if well done. Dr. Savitz did not respond to my similar statement in my Declaration Conclusions. There are many reasons a study cannot lead to positive results, depending upon the size of the population, the control group, and the exposure assessment. When exposure, in this case to EMF/R, comes from multiple sources and one can measure only one source, this will bias results toward not finding a relationship between exposure and disease, even if a relationship exists.

5. Conclusions cannot and should not be drawn from single studies, but rather one must look at the weight of the evidence. **Even where a subsequent study fails to find something an earlier study did find, the earlier study may be more reliable, particularly if the statistical likelihood is very strong and if the study was conducted without bias**. **Consideration of the weight of the evidence necessitates review of animal, cellular and human studies, as well as consideration of the quality of the research including the exposure assessment, the source of funding and any indication of lack of objectivity or presence of bias of the investigators**. (Emphasis added.)

6. In his declaration Dr.Savitz provides some textbook definitions and descriptions of epidemiology, and acknowledges that epidemiology, when performed

rigorously, particularly when with large numbers of study participants, can infer and begin the process of the establishment of a cause-and-effect relationship (¶6). What he does not say is that epidemiology is not a very sensitive tool, and therefore epidemiological results must be placed in the context of results from studies using other methodologies. This is to say that one must look at the overall weight of the evidence when drawing conclusion about adverse effects.

7. He further acknowledges that toxicology, which he refers to in ¶ 12 as "experiments in the laboratory", can, with the isolation of variables, per ¶12,"be quite informative", and can, as he says in ¶18, demonstrate a cause-and-effect relationship between an agent and its effect upon organisms or cells and establish a causal link to health outcomes.

8. However, rather than reading any of other >60 studies and reviews I submitted, other than one of my review papers, Dr. Savitz indicates in ¶20 that he has reviewed the following RF/MWrelated sources in support of his opinion, all of which are unreliable:

- Six (6) blog entries, online commentaries by non-scientists, and other articles in the popular press – b, c, i, including three (3) commentaries by non-scientists in industry-promoting magazines – f, g, j;

- Two (2) non-peer-reviewed position papers by international, industry-funded entities – d, e;

- Three (3) highly selected journal articles [a biased review (Jauchem), a research report that has been discredited by most in the scientific community (Frei) and an editorial (Ahlbom and Feychting) by authors with conflicts – h, l, m;

- The Portland Schools' Wi-Fi manufacturer's position paper – k.

9. Additionally, four (4) conflicted RF/MW-related, secondary sources (reviews) are cited in ¶s 8 and 14: Ahlbom 2009, also cited in ¶32,and Swerdlow (ICNIRP Chair) 2011,Valberg (Gradient Corporation, which specializes in toxic-tort litigation against plaintiffs) 2007 and Vecchia (ICNIRP Chairperson and physicist) 2009, the latter two cited also in ¶22.

10. Other citations in ¶14 are terciary-source governmental agencies' (some international) and non-governmental organizations' position papers and fact sheets, which are generally drawn from ICNIRP positions.

11. **Missing from the declaration are the summary analyses of RF/MW radiation effects, specifically of brain cancer from use of cell phones (Hardell**

et al., 2008; Khurana et al., 2009; Kundi et al., 2009), each of which concludes that there is an elevation in risk of brain cancer with prolonged use of cell phones. (Emphasis added.)

12. With regard to extreme low frequency (ELF) documents, the 11 citations in ¶5-6 are studies confirming harmful effects such as cancers in adults and children, neurodegenerative disease and cardiovascular disease, with strong statistical certainty. They include Savitz's own authored papers and two others. **Noteably missing are the meta-analyses of ELF effects by Wartenburg (1998), Greenland et al., (2000) and Ahlbom et al., (2000), each of which concludes, based on the weight of evidence, that ELFexposure is associated with elevated risk of childhood leukemia**. (Emphasis added.)

13. In ¶30, two of Savitz's cited ELF studies, Linet et al. (1997) and Ahlbom, Day et al; (2000), find childhood leukemia at exposure levels above 3 or 4 milligauss. These studies were included in the meta-analyses by Ahlbom et al. (2000) and Greenland et al. (2000). For Dr. Savitz **to state that "there is no evidence whatsoever of an association with childhood leukemia" "below 3 or 4 milligauss" is a <u>blatent falsehood</u>**, given the results of his own investigations (Savitz et al., 1988). In addition in both the Linet et al. (1997) and Ahlbom, Day et al (2000) publications there were elevated odds ratios for all exposures greater than 1 mG, although they reached statistical signifance only for levels greater than or equal to 4 mG. For Savitz to describe 3 or 4 milligauss as being "unusually high levels of exposure" is not correct, as exposures much greater than this are common in both residential and occupational settings. (Underlining and emphasis added.)

14. Dr. Savitz has declined to respond directly to any of the peer-reviewed sources references in my report, and gives no indication that he has even read any of them beyond my own Report, as stated *supra*, 9.

15. In some points in his declaration, Dr. Savitz states and/or infers that certain scientific modalities are criterion, when they are not. For example:

a. In response to ¶11, some epidemiologic study types do not require enrollment, especially where exposure to an agent of interest, like RF/MW radiation from school Wi-Fi, is not voluntary, and where statistics are reviewed retrospectively.

b. Per ¶14c, I am unaware of "presumption of safety" as being a justified criterion; certainly there is none in a scientific sense. Even if it were a matter of public policy or law in a particular jurisdiction, it would not apply to a rigorous scientific study.

c. In response to ¶17, he emphasizes inaccurate reporting but fails to mention the underestimation of adverse outcomes risk because of inaccurate exposure

assessment. This is a particular problem when humans and other organisms are exposed to an invisible agent such as RF/MW radiation, especially where they cannot know it is present or harmful, and when exposure to RF/MW radiation comes from a variety of sources.

d. As for¶21a, where the agent, such as constant, longterm, pulse-modulated RF/MW radiation, has been studied in both laboratory and real-world conditions, it is not extrapolative to apply those studies to a variety of deployments thereof. While health studies of WiFi exposure have not yet been done, one does not need to perform those studies in order to conclude that WiFi radiation exposure increases the likelihood of impairments and disease, based on the overall weight of evidence from animal, cellular and human studies.

e. Contrary to the implication in ¶32a, many of the infrastructural (i.e., transmission-tower)-
related studies do provide power density measurements. Knowing precise distances is
not criterion where we have precise intensity measurements.

16. Dr. Savitz is extremely selective in his choices of references. **He references Kheifets et al. (2010) reporting no association between magnetic fields and childhood brain cancer, but fails to mention Kheifets et al. (1999), a paper on which he is a co-author, which reports statistically significant relations between magnetic field exposure and brain cancer in adults**. **Does he really think adults get cancer from magnetic fields but children don't?** He fails to reference any of the studies of **Hardell et al.**, who have the best and most consistent demonstration of elevated brain cancer and acoustic neuroma in relation to cell phone use. He fails to mention the **Interphone study** results, which demonstrated elevated brain cancer with excessive cell phone use, but emphasizes the study of Aydin et al. (2011) that reported no relationship between cell phone use and brain cancer in adolescents, but in fact shows a higher risk for all persons using a cell phone more than once a week. **This is not a responsible review of the literature and certainly does not consider the weight of evidence**. (Underlining and emphasis added.)

17. Dr. Savitz cites the DoD-funded Jauchem 2007 review of RF/MW radiation in occupational and residential settings, which of necessity lacks consideration of all studies beyond 2006. Jauchem discusses heart rate and blood pressure changes, general cardiovascular disease, birth defects and fetal loss, sex birth ratio, headaches, immune function effects, hormonal and hematological effects, free radical levels, dermatitis, hearing changes, chromosome aberrations and more, with an inclination to disregard positive findings, despite their greater strength. **He omits some very important primary sources pertaining to his stated topic,**

including the extremely large epidemiologic study by Ouellet-Hellstrom 1993, Altpeter 1995, Hocking 1996, Szmiegielski 1996, Dolk 1997a,b, Michelozzi 2002, Abelin 2005, and others. Stunningly, he does not even include a study from his own funding source, the US Air Force: Grayson 1996. Many important animal and cell studies are omitted, particularly the excellent real-world Magras 1997, the isolation of modulation as a variable in Penafiel 1997, and the many ground-breaking Panagopoulos studies, 2000 - 2006. Since Jauchem had twice previously reviewed the literature, it is not credible that these omissions were accidental. (Emphasis added.)

18. **Within the relevant community of scientists who also are fairly free of financial conflicts, there is general agreement that both ELF EMF and RF/MW radiation are carcinogenic and teratogenic, and that they produce adverse central nervous system and cardiac effects**. (Underlining and emphasis added.)

[Carpenter reply - End quote]

EXHIBIT 4D-1 (FD):
Testimony of Dr. Roger Mattson given in the proceedings of Lake Cedar Group, LLC, v Board of County Commissioners of Jefferson County (Colorado), 1999. Dr. Mattson, PhD, is an expert in radiation standards and is former Director of U.S. Environmental Protection Agency (EPA) non-ionizing radiation standards activities. Dr. Mattson also did work in the field of ionizing radiation protection at the U.S. Atomic Energy Commission and the Nuclear Regulatory Commission. In his testimony, Dr. Mattson explains that FCC safety guidelines pertaining to RF radiation are in fact **not** a declared safety limit at all. He further asserts that the standards and guidelines set by the U.S. federal government do not address protection from long-term or low-level exposure to RF radiation as a public health policy question. His testimony begins at line 14 and reads in part:

[Mattson 1999 testimony - Begin quote]

...
The public health decision has flown downhill and it's on your desk. ...

Quickly, to recount what the standard is. You have heard the 200 micro-watt per square centimeter referred to by a number of people ... You have also heard no doubt that it's based entirely on thermal effects, that is the cause of heating in tissues and organs of human bodies or animals that have been subjected to this kind of radiation. **To say it's based on thermal effects only means that it takes no account of possible chronic or stochastic effects including cancer that might be**

induced by long term low level radiation of human beings. You should also bear in mind that the standards we are going to talk about are all based on research that was completed basically by 1990. So, when you have heard the researchers earlier tonight say that there has been a marked change in the direction of the research and the results of the research in the last five years **that means none of the standards take account for these long term, low level effects that are now being disclosed**.

Although people petitioned the Federal Communications Commission to include sensitivities of the limiting members of the population when they picked the 200 micro-watts they [the FCC] chose not to. When people said you should include the **non-thermal effects that are available in the literature**, they chose not to. It isn't that they addressed them and found them wanting, they chose not to. When people recommended to the FCC in the rule making to set the 200 micro-watts per square centimeter, that they introduce the concept of ALARA that's applied in every other radiation control activity everywhere in the world, FCC chose to even ignore the comment and not respond to it. This is all in the literature of the background of the development of the Federal Communication Commission standards.

I would point out one more thing about those standards and that is that they're not independently administered. Every other hazard that we are used to dealing with, either the FDA or OSHA or the Nuclear Regulatory Commission, or EPA, has an independent oversight of the promotional agency; what we have with the FCC is much like what we had with the Atomic Energy Commission prior to 1975, when the Congress split up the promotional and regulatory activities of the Atomic Energy Commission.

Finally ... it's clear to me that people are misunderstanding it. Two hundred micro-watts per square centimeter **is not a safety limit**. **No federal agency has set it as a safe limit**; it is a ***guideline*** used by FCC. How do they use it? They use it to decide when to require a particular applicant to do an environmental impact statement. [If the] applicant can make a case that they are going to be below 200 to the affected public, they don't have to do any I.S. If they are over 200 then the FCC regulations say they have to do an E.A., environmental assessment and then the assumption would be that FCC would do any I.S. That's not the same as a safety limit. **FCC is not saying and has not defended 200 micro-watts per square centimeter as safe**. **No one has declared it safe**. It's really important to understand this; it's a bureaucratic approach to how you implement the National Environmental Policy Act.

...

What the FCC says about itself in this same rule making "in the past the commission has stressed repeatedly that it is not a health and safety agency and would defer to the judgement of these expert agencies with respect to determining appropriate levels of safe exposure to RF energy. We continue to believe that we

must place special emphasis on the recommendations and comments of Federal Health and Safety Agencies, because of their expertise and responsibilities with regard to health and safety matters." There is none; **there is no public safety agency in RF**.

...

Another observation: there is a growing body of science on long term effects and low level effects, and there will be some. (Underlining, italics and emphasis added.)

[Mattson 1999 testimony - End quote]

EXHIBIT 4D-2 (FD):

Testimony of Dr. Roger Mattson given in the proceedings of Lake Cedar Group, LLC, v Board of County Commissioners of Jefferson County (Colorado), 2003.

[Mattson 2003 testimony - Begin quote]

...

[F]or my career of about 40 years, ... I have been in the radiation standard setting business at the Environmental Protection Agency, the Atomic Energy Commission and the Nuclear Regulatory Commission, and then the latter part of my career spent managing companies that have to comply with radiation standards. I believe the main reason that people at the local level are uncertain what to do about these situations is the simple fact that the federal government is not minding the store. These three things I've listed on the slide convince me of that.

First our government has no entity that will say there are no health effects from long term low level exposures to non-ionizing radiation. One of the reasons for that is that in the past five years the Environmental Protection Agency has spent a total of $25,000 in research in this area even though it is the health agency designated to be in charge of protecting people from non-ionizing radiation. And finally no one at the federal level is looking into the effects of long term exposure even though the Federal Communications Commission has called for more research along with EPA, National Institutes of Health, The National Institute of Occupational Safety and Health, the Food and Drug Administration, the National Telecommunication Information Agency and the National Council on Radiological Protection. They did so in 1999 in a letter to the Chairman of the IEEE Committee that writes the standards that the FCC endorses. They listed in their letter, in the attachment to their letter, dozens of things that are wrong with the current standard. It's not just that it doesn't address long term effects and low level effects, but lots of other things are wrong with it. So as you see on this next slide, because the federal government ... is not minding the store, **the current FCC standards are flawed**. **There are no standards that address long term low level exposures**. There's no organized research and they're out of touch with what's

going on in the rest of the world. A number of other countries have lowered their standards for non-ionizing radiation exposure to the public by significant amounts ... .

In not addressing low level chronic exposure the FCC is ignoring recent research which indicates long term effects of low level exposures. One of the things that hasn't come out in the medical testimony you heard this evening is ... how recent these data are. Most of it, 90% of the data on low level, long term effects, that data is in papers published since 1990. They're international in scope, they're up in the many dozens now. ... I have a collection at home that's about 60 also, so there's a growing international body of scientific evidence that non-ionizing radiation causes health effects.

Locally we've got the Colorado Department of Health that found the results that have been presented to you, the excess of brain tumors local to the towers. That study is not different than the studies of the public near towers in Italy, Hawaii, Great Britain, Australia. They all indicate adverse health effects due to low level, long term exposure to radio frequency radiation.
...
The standards that exist are flawed. You know they're flawed. You've been shown why they're flawed. You have a responsibility. **If there are health effects** and if you approve the rezoning request **then you as the people who have granted the authority are accountable for those effects**. Not the federal agencies who have said "our standards are not adequate for these long term low level exposures."
...
Don't let these people hide behind a flawed federal standard. ... They continue to do it today.

[Mattson 2003 testimony - End quote]

[Mattson 2003 testimony - Powerpoint slide 6]:

Recent Research Indicates Long Term

Effects of Low Level Exposures

- Since about 1990 there has been a **growing international body of scientific evidence** that non ionizing radiation causes health effects for long term exposures well below the current FCC standards.
- The **Colorado Department of Health** has studied Jeffco neighborhoods and **found an excess of brain tumors**, a scientifically recognized effect of non ionizing radiation.

- Studies of the public near TV towers in **Italy, Hawaii, Great Britain and Australia also indicate that there are adverse effects of** exposure to low levels of radiofrequency radiation**.**

  [Mattson 2003 testimony - End]

EXHIBIT 9B (FD):
Dr. Martin Pall testimony on adverse health effects of wireless smart meters at Massachusetts Statehouse, 2017.

EXHIBIT 14 (FD):
Health Effects of Cell Phone Use. U.S. Senate testimony of Nobel Co-laureate Dr. Devra L. Davis, PhD, MPH, University of Pittsburgh Professor of Epidemiology, Visiting Professor of Medicine, Hebrew University Hadassah Medical School, and President, Environmental Health Trust. A lecture by Dr. Davis entitled: *The Truth About Mobile Phone and Wireless Radiation*, follows her Senate testimony. Dr. Davis states in her Senate testimony: "The work that's been done on the ***Comet Assay***, that **shows double-strand breaks in DNA** after exposure to cell phone radiation, is ***very strong evidence experimentally***. If we tie that with the human studies of Dr. Sadetzki and others that have looked at people who have ten years of exposure or more, we put them together, and we have strong evidence" ***that exposure to a cell phone causes cancer***. Dr. Davis also testifies to the tactics used by the wireless phone industry to suppress and discredit the scientific research which showed adverse biological effects of DNA damage caused by radiation from cell phones.

EXHIBIT 20B (FD):
Testimony of Dr. Henry Lai given in the proceedings of Lake Cedar Group, LLC, v Board of County Commissioners of Jefferson County (Colorado), 1999. Dr. Lai, PhD, is one of the world's foremost experts in the use of comet assay techniques in the study of DNA damage, genotoxicity, and biological effects of RF radiation. Dr. Lai's testimony begins on p. 6091 (the second page in the PDF file).

Dr. Lai testified that when DNA is exposed to low level, low-intensity radiofrequency radiation, the DNA strands break up into small pieces. Because nerve cells inside the brain have a low capacity to repair this type of DNA breakage, it can cause death of nerve cells. Dr. Lai further testified: "[A]nother possibility is that mutation can occur and the cell becomes cancerous. Another type of consequence is so called Neural-degenerative diseases such as Alzheimer

disease, and Huntington disease, and Parkinson disease." (Underlining and emphasis added.)

EXHIBIT 21E (FD):
Testimony of Dr. Ann Lee, MD, before California State Assembly committee. Dr. Lee testified in part:

"As a medical doctor, I have read peer-reviewed papers and other studies from within the over 20,000 well-established scientific studies on the bioeffects of radiofrequency microwave radiation. And I do testify that microwave radiation, such as that from the wireless facilities to be deployed ... have been shown to cause neurological damage, cardiac dysfunction, reproductive harm, immune compromise and cancer. Our body's function is dependent on the cellular electrical stability of its organs.

"Therapeutic radiation, such as pulse-modulated electromagnetic frequencies used for medical purposes, are dose- and time-limited for a reason—because prolonged exposure will cause more harm than good. Exposure to microwave radiation without cessation, while lacking consent, and contrary to the will of the people, will harm everyone—in violation of the protection of safety guaranteed by the California Constitution."

EXHIBIT 21G (FD):
Testimonies of Dr. Paul Heroux, PhD, before Michigan House Energy Policy Committee on May 29, 2018 and October 4, 2018. Citing specific scientific studies in his testimony, Dr. Heroux addresses the effects of wireless radiation on health beginning at the 1:57 minute-mark. His testimony is partially transcribed as follows:

"The effects of wireless on health, scientifically, are very, very clear. But industry, in its position, has used its influence on national committees, on professional committees, to provide endless discussion of the science, which apparently led to no conclusion. But now, with the statements of the International Agency for Research on Cancer, with a succession of animal studies by Chou in 1992, by Repacholi in '97, and by the NTP recently, confirmed by Ramazzini in Italy, **there is, scientifically, evidence that is so strong that you can be certain that the standards used by the FCC to manage health effects are wrong**. (Underlining and emphasis added.)
...
"[The NTP] is a twenty-five million dollar study ... that was supposed to demonstrate that there were no effects of radiation below thermal. And in fact,

it demonstrated exactly the opposite. And it follows on the heels of two major studies on animals that said exactly the same thing. The writing is on the wall. It's whether you and the society that we live in want to recognize it. (Emphasis added.)

...

"There's other ways to do this. The signal has to get through. But not at the cost of the health of citizens. There's very real health effects that are documented by epidemiologists. So, you have to heed this warning now, or we will see each other later under less favorable circumstances."

(Chou (1992) found a "statistically significant increase in malignant tumors in rats chronically exposed to RFR" at SAR levels of "0.15 - 0.4 W/Kg". Repacholi (1997) found that "Lymphoma cancer rate doubled with two 1/2-hr exposures per day of cell phone radiation for 18 months (pulsed 900 MHz cell signal)" at SAR levels of "0.13 - 1.4 W/Kg".)

EXHIBIT 21H (FD):

Testimony of Dr. Sharon Goldberg, MD, before Michigan House Energy Policy Committee, October 4, 2018. https://www.youtube.com/watch?v=CK0AliMe-KA Dr. Goldberg's testimony addresses many of the issues concerning the lack of safety of wireless devices and technology.

EXHIBIT 21I (FD):

Testimony of Dr. Angie Colbeck, MD, before Michigan House Energy Policy Committee, October 4, 2018.

EXHIBIT 29C-7 (FD):

Testimony and commentary given by Dr. Karl H. Maret, MD, MEng, to David M. Aaron, Esq., *In the Matter of FortisBC Inc. Application for a Certificate of Public Convenience and Necessity for the Advanced Metering Infrastructure Project ~ Project No. 3698682*, Jan. 23, 2012. Dr. Maret's testimony reads in part:

[Maret testimony and commentary - Begin quote]

Expert Opinion Summary

It is my opinion that the RF Mesh Network Meters that are part of the proposed FortisBC Inc. Automated Metering Infrastructure may constitute a risk of serious damage to health by biological nonthermal mechanisms. The most vulnerable subpopulation would be children, pregnant women, the elderly, individuals with

illnesses and electrically hypersensitive persons. **It is in the nature of the nonthermal RF pulsations and not the power density levels that constitute the adverse biological effects of the meters**. (Underlining and emphasis added.)

...

Question 16:

What comments do you have, if any, regarding Fortis' response to CSTS 5 IR#2, question 44.4 as set out?

44.4
Does exposure assessment, as discussed in the Exponent Report at pages 8, 9 & 47, take into consideration cumulative effects of prolonged exposure to low doses?

[Fortis BC] Response:

The evaluation of potential health effects of any exposure considers the duration of exposure with regard to the potential for biological changes or health effects to evolve over time. Safety Code 6 addresses the potential cumulative build-up of heat in tissues by time-averaging exposure to radiofrequency fields and so prevents adverse effects of exposure.

Dr. Maret Response:

The evaluation of potential health effects of any RF exposure has to consider the duration of exposure. Health Canada Safety Code 6 addresses the potential cumulative build-up of heat in tissues by time-averaging exposure to radiofrequency fields to prevent adverse effects of exposure. The averaging time specified in the standard is related to the thermal time constant in humans. A six minute time, chosen by some standards like the ICNIRP, corresponds to the thermal time constant of sensitive tissues like eyes and testes. These time constants relate to the body's thermoregulatory responses like increased blood flow which are the primary concern when setting thermal exposure standards. As mentioned earlier, **these standards do NOT concern themselves with low level, non-thermal RF exposure safety guidelines**. (Emphasis added.)

Non-thermal effects continue to be controversial and have long been denied by many biophysicists to even be possible. Volkow's work (2011) has clearly demonstrated using PET scans that increased glucose utilization in various brain tissues occurred after non-thermal RF power density exposure in humans. **Clearly non-thermal RF radiation can cause neurophysiological changes in the brain**. Other aspects of long-term exposure were discussed earlier (see page 22). (Underlining and emphasis added.)

Nonetheless, the nature of cumulative RF exposure is controversial because few epidemiological studies have utilized long-term monitoring instrumentation directly on exposed subjects. These types of monitors are now available for these types of measurements. Long-term studies take time and are costly. Human exposure to low level base station radiation has shown long term adverse health effects as described earlier. With the mounting number of epidemiological studies describing long term effects of RF radiation that now exist, it is my opinion that a precautionary approach is necessary rather than extrapolating the absence of risk as is currently being done with the higher exposure guidelines promulgated by the ICNIRP and Health Canada Safety Code 6. Israel has adopted long- term exposure levels that are ten times lower than their short-term exposure guidelines. Russia and China have similarly set lower exposure standards based in part on long term exposure concerns.

In addition, the type of modulation, the temporal nature of the pulsing RF signals, the presence of critical biological windows at resonant power density levels, and the vulnerability to exposure within the circadian cycle are all involved when considering long-term exposure as described in questions 2, 3 and 4 earlier.

With reference to the response to question 44.4 stated above, I believe it is misleading to state that "Safety Code 6 addresses the potential cumulative build-up of heat in tissues by time-averaging exposure to radiofrequency fields and so prevents adverse effects of exposure" since this approach only seeks to mitigate thermal thresholds from being exceeded. The statement might better have been expressed by saying "…by time-averaging exposure to radiofrequency fields and so prevents adverse effects of RF exposure leading to tissue heating effects." This would clarify their reasoning and the criteria being used for claiming the "prevention possible adverse health effects" which from their perspective do not involve non-thermal radiofrequency fields.

Volkow ND, Tomasi D, Wang G, Vaska P, Fowler JS, Telang F, Alexoff D, Logan J, Wong C (2011), Effects of Cell Phone Radiofrequency Signal Exposure on Brain Glucose Metabolism. JAMA. **305** (8):808-813. doi: 10.1001/jama.2011.186

[Maret testimony and commentary - End quote]

EXHIBIT 45A (FD):

Declaration of Dr. Andrew Goldsworthy, BSc, PhD, Lecturer in Biology, Imperial College, London. (U.S. District Court Civil Action No. 3:11-cv-00739-MO, pp. 7-10.) Reads in part:

Mechanisms

"Many people suffer immediately or in the short- or long-term one or more of a wide variety of symptoms when exposed to weak, radiofrequency (RF) radiation, including microwave (MW) radiation, including that from laptops and Wi-Fi.

"I will explain just how these effects can arise, and virtually all of them share a common mechanism. **The evidence fits together and leaves little doubt that the majority of the reported effects are real** and must be taken seriously.

"I have researched the frequently reported effects of RF/MW electromagnetic fields to see if there are any underlying threads that may indicate a common mechanism and then to try to change the characteristics of the signal to minimize these effects. The most important is due to effects on calcium efflux from cell membranes. These include cognitive impairments, early dementia, multiple allergies, DNA fragmentation, loss of fertility, increased cancer risk, and electromagnetic hypersensitivity.

Calcium Efflux Effects

"Most of the damage done by digital telecommunications is not due to heating but rather by the electrical effect their pulsating signals have on living tissues, which occurs at much lower energy levels.

"The human body can act as an antenna; and the signals from external RF/MW radiation make electric currents flow through the body in time with the pulsations. It is these that do the bulk of the damage, by destabilizing the delicate membranes that surround each cell and which also divide it into internal compartments such as mitochondria (the energy factories of the cell), and the lysosomes (the cell's recycling factories).

"All of these membranes are just two molecules thick and have a similar basic structure. They are liquid crystals, made largely of negatively charged molecules (which repel one another) stabilized by divalent positive ions (mostly calcium) that sit in between them by mutual attraction and hold them together like mortar holds together the bricks in a wall.

"It was first shown by Bawin *et al*. in the 1970s that weak, amplitude-modulated (AM) radio waves, where the strength of the signal rises and falls in modulation at low frequencies, could remove some of this calcium from brain cell membranes. This destabilizes these membranes and makes them more likely to leak. The effects are strongest with modulation in the extremely low frequency (ELF) range and in radio waves that have been amplitude-modulated with ELF. *Pulse-modulation is an extreme form of amplitude modulation, where the signal goes entirely off for a short period of time, resulting in bursts of energy*.

"The low-frequency pulsations of Wi-Fi infrastructure and Wi-Fi laptops will behave in much the same way upon biologic tissues. This is important in the brain, because the normal function of brain cells depends on the controlled passage of specific ions through their membranes. When these membranes leak, ions flow through them in a relatively uncontrolled way, which results in brain hyperactivity and may cause result in attention deficit hyperactivity disorder (ADHD) in some people. When this occurs in the brain of a fetus or young child, it prevents normal brain development, which may result in autism (http://mcsamerica.org/june2011pg2345.pdf), as discussed further below. Wi-Fi should therefore be considered as an impediment rather than an aid to learning and may be particularly hazardous for children and pregnant teachers.

Modulation

"In theory, unmodulated radio and microwaves should not release calcium from cell membranes; because there is not enough time to replace the calcium with another ion before the field reverses. However, as shown by Bawin *et al*. (1975) calcium release does occur if the RF/MW signal is modulated at biologically-active low frequency, which suggests that living cells can demodulate it. The simplest way to demodulate a signal is to rectify it. Living cell membranes contain countless voltage-gated ion channels that open only when voltage across the cell membrane reaches a pre-determined value. These can rectify low-frequency signals but, because they require the mechanical opening and shutting of the channels, cannot work at MW frequencies. However, any ion channel, provided it is open at all, should be able to rectify, even at MW frequencies, due to the presence of the membrane potential. The membrane potential is a natural voltage of the order of 100mV across living cell membranes, which gives a voltage gradient of about 10 million volts per meter along each ion channel (which is about 10nm long). This voltage gradient gives the channel different electrical properties in either direction. In effect, the whole membrane behaves as an array of point contact Schottky diodes, which allows even MW signals to be rectified and demodulated. The extracted low frequencies then appear across the membrane, where they can do most damage. This principle has been nicely illustrated by the construction of a complete radio set from a single carbon nanotube having a similar diameter to an ion channel (see http://tinyurl.com/m4u75o). When a voltage gradient was applied along the tube it could both **amplify** and **demodulate** a radio signal, even at MW frequencies. We should therefore not be surprised to find that the human body can extract biologically active and potentially damaging low frequencies from weak Wi-Fi radiation and that such radiation, when continued throughout the school day, and perhaps overnight at home, presents a serious threat to many children." (Underlining and emphasis added.)

EXHIBIT 45C (FD):
Declaration of Dr. Magda Havas, BSc, PhD, Associate Professor of Environmental & Resource Studies, Trent University. (U.S. District Court Civil Action No. 3:11-cv-00739-MO, p. 9.) Reads in part:

"The late physics Professor Neil Cherry PhD of Lincoln University, New Zealand, stated it best:

'Electromagnetic fields and radiation damage DNA and enhance cell death rates and therefore they are a Ubiquitous Universal Genotoxic Carcinogen that enhances the rates of Cancer, Cardiac, Reproductive and Neurological disease and mortality in human populations. ***Therefore there is no safe threshold level. The only safe*** *exposure level is zero, a position confirmed by dose-response trends in epidemiological studies.*' http://www.neilcherry.com/.

"The Environmental Protection Agency has recommended that electromagnetic radiation (which includes WI-FI radiation) be classified as a 'probably human carcinogen.' United States Environmental Protection Agency, *Evaluation of the Potential Carcinogenicity of Electromagnetic Fields, External Review Draft, No. EPAl600/6-901005B, October 1990*. The following is a statement from Norbert Hankin PhD, EPA Environmental Scientist, December 19, 2000:

'This ... should not be overlooked ... the potential for an impact by wireless communications technology on a child's educational process, i.e., by possibly affecting learning ability. [It] stems from recent studies involving short-term exposures that demonstrated subtle effects on brain functions, produced by low-intensity, pulse-modulated radiofrequency radiation ... [E]ven a slight degree of impairment of learning ability over years of exposure ... may negatively affect the quality of life that could be achieved by these individuals when adults.'" (Underlining and italics added.)

EXHIBIT 45J (FD):
Rebuttal Testimony of Dr. Magda Havas before the State of Iowa Utilities Board, Docket No. SPU-2018-0007. https://ehtrust.org/wp-content/uploads/Rebuttal-Testimony-Magda-revised-42-1.docx

Reads in part:

"Q13: Can you give us an example of an experiment that tested the effect of MW radiation on EHS?

"A: An example of an experiment is one we did testing the effect of MW radiation from a mobile phone base station on heart rate variability (HRV) [Exhibit DD]. We did a double-blind, placebo controlled study with 25 human volunteers in Colorado and found that some of them developed either tachycardia (rapid heart rate) or arrhythmia (irregular heart rate) when exposed to 2.4 GHz from a cordless phone base station placed near their body. Their body went into a "fight, flight or faint" response as indicated by their autonomic nervous system (ANS) with an up regulation of their sympathetic tone and a down regulation of their parasympathetic tone. When this happens the person believes they are having either an anxiety attack or a heart attack. The former is a more accurate description of what is happening. When the cordless phone base station was disconnected from the electrical outlet, their heart rate and their autonomic nervous system returned to normal. Note that some of the early research also indicates that MWs affect the autonomic nervous system.

...

"There is evidence that MWs affect the heart, the ANS, as well as the blood [Exhibit EE]. My own blood becomes more viscous when I am exposed to MW radiation for 10 minutes and this can be observed under a microscope (Plate 1). Symptoms of this can involve cold, numbness or tingling in fingers and toes; dizziness and nausea; with more severe symptoms leading to blood clots, strokes, or heart attacks."

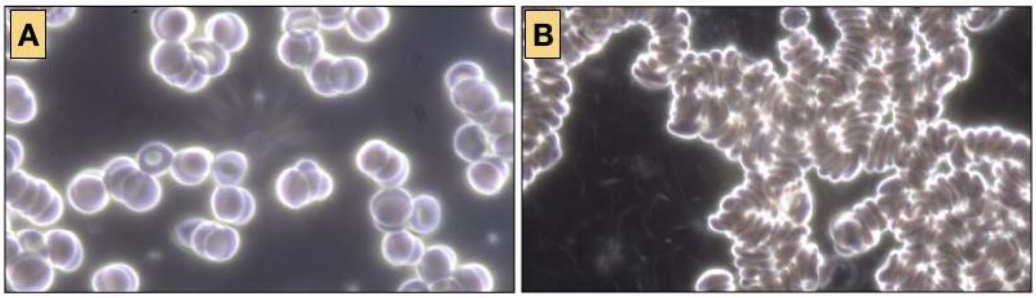

Plate 1. Live blood under dark field microscopy. (A) is in an electromagnetically clean environment and (B) is after a 10-minute exposure of the body to microwave radiation generated by a home Wi-Fi router. The red blood cells on the right (B) are sticking together in what is known as rouleau formation. This interferes with exchange of gases and nutrients and can lead to serious health problems and is one of the responses of people who are hypersensitive to electromagnetic radiation.

"Q14: Do any governing bodies recognize EHS?

"A: Yes. The WHO recognizes EHS but would prefer to call it *idiopathic environmental intolerance attributable to electromagnetic fields*. At their International Seminar in Prague, the WHO made the following statement about EMF hypersensitivity [Exhibit W, pages V, 7]:

. . . a phenomenon where individuals experience adverse health effects while using or being in the vicinity of devices emanating electric, magnetic, or electromagnetic

fields (EMFs) … Whatever its cause, EHS is a real and sometimes a debilitating problem for the affected persons … Their exposures are generally several orders of magnitude under the limits in internationally accepted standards.

"What this means is that the international standards (as well as those in the U.S. since they are the same) do not protect people who have EHS."
...
"Each time a smart meter sends out a blast of radiation, it is like an alarm bugle to the cells in the human body and contributes to cellular stress as indicated by stress protein production and these blast (sic) happen day and night, week after week, and year after year."
...
"Dr. Jonathan M Samet, MD, University of Southern California, who was the Chair of the international group of scientists responsible for the Class 2B ("possibly" carcinogenic) RF designation at IARC, stated the following at a press conference: [http://magdahavas.com/iarc-declares-rf-from-cell-phones-and-cell-towers-dangerous/ at 3:11 in video] [Exhibit ZZ]:

'*The designation of Group 2B is radio frequency electromagnetic fields and is unspecified as to source. So the Group 2B classification would have broad applicability to sources with this type of emissions*.'

"In other words, **radio frequency radiation has been associated with cancers and it is virtually irrelevant if these frequencies are generated by smart meters, cell phones, Wi-Fi or some other source of MW/RF radiation**. (Underlining and emphasis added.) If someone is allergic to peanuts it doesn't matter if the peanut is in a chocolate bar or in a sandwich. A more accurate statement regarding smart meters would be as follows,

'*Scientific research has identified that RFR is hazardous to human health at levels well below international guidelines and since smart meters emit RFR they are also potentially hazardous to human health*.'

"Q27: Do you agree with Dr. Valberg's statement (page 1) that: *'… a large number of scientific groups have reviewed research findings on potential health effects of RF waves without finding credible evidence that RF intensities below protective guidelines levels pose a threat to health*.'

"A: This I consider a misleading statement as an equally large group of scientists and medical doctors are asking that the guidelines currently available in the United States and those recommended by ICNIRP be reduced because intensities well below guidelines are making people ill. Since 1997, EMF and RF experts have submitted at least 35 appeals stating that levels below existing guidelines are

making people ill and that governments need to develop non-thermal guidelines that truly protect the health of the pubic and especially of children and pregnant women."

...

"We have also had notifications from the WHO, FCC, Health Canada, American Academy of Paediatrics (60,000 Paediatricians and Paediatric Surgeons), the American Academy of Environmental Medicine and various teachers unions that children are more vulnerable than adults to RF radiation and should limit their exposure."

...

"**Q28: Is the scientific community conflicted about whether smart meters and cell phones are safe?**

"A: A non-expert may conclude that the scientific community is conflicted when it comes to determining whether or not existing guidelines are safe. However, an examination of the source of funding and the results of studies indicates that research funded by industry have a preponderance of "no effects", while those independently funded are showing a preponderance of significant adverse effects."

EXHIBIT 45R-3 (FD):

Testimony of Dr. Anthony B. Miller, MD, Professor Emeritus at the Dalla Lana School of Public Health, University of Toronto, before the Canadian Parliament House of Commons Standing Committee on Health, April 23, 2015.
https://www.ourcommons.ca/DocumentViewer/en/41-2/HESA/meeting-57/evidence and
https://openparliament.ca/committees/health/41-2/57/dr-anthony-miller-1/

Dr. Miller testified on the **inadequacy** of Canada's *Safety Code 6* guidelines in providing protection from low-level radiofrequency radiation exposure. The *Safety Code 6* guidelines are practically identical to the FCC guidelines for RF exposure. Dr. Miller's testimony reads in part:

"Mr. Chair, members of the committee, thank you very much for giving me the opportunity to present on Health Canada's review of the evidence for Safety Code 6, which I believe has led to unsafe conclusions.

"I am a physician and epidemiologist specializing in cancer etiology, prevention, and screening. I have performed research on ionizing radiation and cancer, electromagnetic fields and cancer, and other aspects of cancer causation. I have served on many committees assessing the carcinogenicity of various exposures, including working groups of the International Agency for Research on Cancer, commonly known as IARC, of which Canada is a member. ...

"I was a visiting senior scientist in the monographs program in IARC in September 2011 until January 2012, where as part of my duties I reviewed the scientific literature that was used by a working group to designate radio frequency fields as a class 2B carcinogen, that is, a possible carcinogen. I was also one of the peer reviewers invited by the Royal Society of Canada to review the draft report of the Royal Society panel on Safety Code 6."

...

"Since the IARC review, which identified radio frequency fields as a possible human carcinogen, there had been a number of studies that have been reported. In my view—and that of a number of colleagues ...—**these studies, we believe, reinforce the evidence that radio frequency fields are not just a possible human carcinogen but a probable human carcinogen, putting it in the category 2A**. It would be impossible to ignore such a hazard in regulatory approaches."

...

"It's important to recognize that there are no safe levels of exposure to human carcinogens. Although **risk increases** with increasing intensity of exposure, and for many carcinogens, such as tobacco smoke, **even more with increasing duration of exposure**, the only way to avoid the carcinogenic risk is to avoid exposure altogether. ..."

...

"We have brain cancers and parotid gland tumours, which are tumours of the salivary gland. .... In Israel recently a study identified increasing risk of these cancers, particularly with increasing exposure.

"Given the long natural history of cancer and the fact that human populations have not been exposed for a sufficient length of time to exclude a carcinogenic effect, it is in my view extremely important to adopt a precautionary approach to the exposure of humans, particularly children, to radio frequency fields. We should note that ... **in the case of cell towers and smart meters, the exposure they receive is outside their control**. Then, with the people who manufacture these devices and those who promote Wi-Fi in all sorts of instances, **we're reaching a situation where homes are being saturated with radio frequency fields**."

...

"[T]o avoid a potential epidemic of cancer caused by radio frequency fields from Wi-Fi and other devices, we should strengthen the codes that are meant to protect the public. In my view, Health Canada has not done an adequate job. **Safety Code 6, in its current iteration, needs to be re-revised**." (Emphasis added.)

EXHIBIT 45R-4 (FD):

Testimony of Dr. Anthony B. Miller, MD, before Toronto Council on November 20, 2013, concerning risks of RF exposure.
https://www.youtube.com/watch?v=wARxnaxrRKk

In his testimony, Dr. Miller states that the results of additional studies (since the IARC classification in 2011 and up to the time of his 2013 testimony) support upgrading the IARC classification of RF radiation to a Group 2A, probable human carcinogen.

4. Exhibits and Partial Transcripts of Complete, Peer-reviewed Scientific Research Studies with Conclusions

This section includes the following:

Exhibit Nos. 1L, 6G, 7, 16, 17B, 17C, 17E, 19B, 20C, 23, 24L, 24N, 25, and 44G.

All of the exhibits listed within this section constitute directly relevant and highly credible evidence of absolutely and completely reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

Also, because Dr. William J. Rea, MD, FACS, the principal author and declarant in Exhibit 1L is physically unable to testify in these proceedings, his research brought forth in this exhibit constitutes and can be received as credible, competent and substantial evidence under the provisions of Pa.R.E. 804(a)(4).

EXHIBIT 1L (FD):
Electromagnetic field sensitivity. Rea WJ, Pan Y, Fenyves EJ, et al., Journal of Bioelectricity. Conclusion reads in part:

"It is clear that EMF sensitivity is a real phenomenon in some environmentally sensitive patients, because some had consistent reactions while none of the controls did. In conclusion, it is evident that ... clearly EMF sensitivity exists and can be elicited under environmentally controlled conditions."

EXHIBIT 6G. (FD): *Electromagnetic Field Effects on Cells of the Immune System: The Role of Calcium Signaling*. J. Walleczck, Research Medicine and Radiation Biophysics Division, Lawrence Berkeley Laboratory, University of California, with support of Director, Office of Energy Research, Office of Biological and Environmental Research, Medical Applications Division, U.S. Department of Energy (LBL--31097 DE92 000852 July, 1991). Reads in part:

"[T]here is now considerable evidence in support of the existence of low-frequency EMF effects in cells of the immune system (for examples see Tables 1 and 2) and that **mechanisms involving Ca^{2+}-dependent signal transduction mechanisms are probably participating in the mediation of weakfield effects on immune cells**. **The fact that such field effects apparently do exist represents a remarkable discovery for immunology because it suggests that the immune system can be influenced by or respond to electrical currents and magnetic fields too weak in intensity to act through any thermal mechanism**. **A similar responsiveness to weak EMFs has also been documented for cells and tissues of the neuroendocrine and the musculoskeletal system indicating that EMF sensitivity might be a general property of biological systems** (see refs. 1-7)." (Underlining and emphasis added.)

EXHIBIT 7 (FD):
Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. Martin L. Pall. J. Cell. Mol. Med. Vol 17, No 8, 2013 pp. 958-965.

EXHIBIT 16 (FD):
Nerve Cell Damage in Mammalian Brain after Exposure to Microwaves from GSM Mobile Phones. Salford, L., Brun, A., Eberhardt, J., Malmgren, L., & Persson, B. R. Environmental Health Perspectives, 111(7), 881-883.

EXHIBIT 17B (FD):
Blood-brain barrier permeability in rats exposed to electromagnetic fields used in wireless communication. Bertil R.R. Persson , Leif G. Salford and Arne Brun. Wireless Networks 3 (1997) 455–461.

EXHIBIT 17C (FD):
Permeability of the bloodbrain barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50 and 200 Hz (Abstract). Salford LG, Brun A, Sturesson K, Eberhardt JL, and Persson BRR. Microscopy Research and Technique 27: 535-542. 1994. doi.org/10.1002/jemt.1070270608

EXHIBIT 17E (FD):
Whole body exposure with GSM 900MHz affects spatial memory in mice A.F. Fragopoulou, et al., Pathophysiology 17 (2010) 179–187. Reads in part:

"These results clearly demonstrate that exposure of mice to EMF deriving from commercially available mobile phone at SAR values within the ICNIRP guidelines for 2 h prior to the daily Morris water maze trial, affects the spatial learning and memory function in Balb/c mice."

EXHIBIT 19B (FD):
Effects of Cell Phone Radiofrequency Signal Exposure on Brain Glucose Metabolism. Nora D. Volkow, MD, Dardo Tomasi, PhD, Gene-Jack Wang, MD, Paul Vaska, PhD, Joanna S. Fowler, PhD, Frank Telang, MD, Dave Alexoff, BSE, Jean Logan, PhD, Christopher Wong, MS. JAMA. 2011;305(8):808-814. https://jamanetwork.com/journals/jama/fullarticle/645813 Reads in part:

"In healthy participants and compared with no exposure, 50-minute cell phone exposure was associated with increased brain glucose metabolism in the region closest to the antenna."

EXHIBIT 20C (FD):
DNA damage in Molt-4 T-lymphoblastoid cells exposed to cellular telephone radiofrequency fields in vitro. Phillips, JL, et al., Bioelectrochemistry and Bioenergetics 45 (1998) 103–110. Study using ***comet assay*** techniques to measure DNA damage due to RFR exposure. Reads in part:

"These studies were performed at low SAR (average= 2.4 and 24 $\mu W\ g^{-1}$ for iDEN® and 2.6 and 26 μWg^{-1} for TDMA) in studies designed to look for athermal RF effects. The alkaline comet, or single cell gel electrophoresis, assay was employed to measure DNA single-strand breaks in cell cultures exposed to the radiofrequency (RF) signal as compared to concurrent sham-exposed cultures. Tail moment and comet extent were calculated as indicators of DNA damage. ... It was found that: ... exposure of cells to the iDEN® signal at an SAR of 24 $\mu W\ g^{-1}$ for 2 h and 21 h significantly increased DNA damage ... ."

EXHIBIT 23 (FD):
NTP Technical Report on the Toxicology and Carcinogenesis Studies in Hsd:Sprague Dawley Sd Rats Exposed to Whole-Body Radio Frequency Radiation at a Frequency (900 MHz) and Modulations (Gsm and Cdma) Used By Cell Phones. U.S. National Toxicology Program Final Report, November 1, **2018**.

The **final** conclusions of the study represent the consensus between NTP and a panel of external scientific experts who thoroughly peer-reviewed the NTP technical reports at a public meeting in March 2018.

The radiofrequency of 900 MHz, upon which this evidence was established, is the same or nearly the same frequency transmitted by one of the two RF antennas used in the AMI smart meter devices deployed by PPL in its wireless mesh network.

The NTP report reads in part:

[NTP final report - Begin quote]

EXPLANATION OF LEVELS OF EVIDENCE OF CARCINOGENIC ACTIVITY

The National Toxicology Program describes the results of individual experiments on a test agent and notes the strength of the evidence for conclusions regarding each study. Negative results, in which the study animals do not have a greater incidence of neoplasia than control animals, do not necessarily mean that a test agent is not a carcinogen, inasmuch as the experiments are conducted under a limited set of conditions. ***Positive results demonstrate that a test agent is carcinogenic for laboratory animals under the conditions of the study and indicate that exposure to the test agent has the potential for hazard to humans***. (Underlining, italics and emphasis added.)

...

Five categories of evidence of carcinogenic activity are used in the Technical Report series to summarize the strength of evidence observed in each experiment: two categories for positive results **(clear evidence and some evidence)**; one category for uncertain findings **(equivocal evidence)**; one category for no observable effects **(no evidence)**; and one category for experiments that cannot be evaluated because of major flaws **(inadequate study)**. These categories of interpretative conclusions were first adopted in June 1983 and then revised on March 1986 for use in the Technical Report series to incorporate more specifically the concept of actual weight of evidence of carcinogenic activity. For each separate experiment (male rats, female rats, male mice, female mice), one of the following five categories is selected to describe the findings. These categories refer to the strength of the experimental evidence and not to potency or mechanism.

• **Clear evidence** of carcinogenic activity is demonstrated by studies that are interpreted as showing a dose-related (i) increase of malignant neoplasms, (ii) increase of a combination of malignant and benign neoplasms, or (iii) marked increase of benign neoplasms if there is an indication from this or other studies of the ability of such tumors to progress to malignancy.

• **Some evidence** of carcinogenic activity is demonstrated by studies that are interpreted as showing a test agent-related increased incidence of neoplasms

(malignant, benign, or combined) in which the strength of the response is less than that required for clear evidence.

• **Equivocal evidence** of carcinogenic activity is demonstrated by studies that are interpreted as showing a marginal increase of neoplasms that may be test agent related.

• **No evidence** of carcinogenic activity is demonstrated by studies that are interpreted as showing no test agent-related increases in malignant or benign neoplasms

• **Inadequate study** of carcinogenic activity is demonstrated by studies that, because of major qualitative or quantitative limitations, cannot be interpreted as valid for showing either the presence or absence of carcinogenic activity. (p.16)

...

CONCLUSIONS

GSM-Modulated RFR

Under the conditions of this 2-year whole-body exposure study, there was ***clear evidence*** *of carcinogenic activity** of GSM-modulated cell phone RFR at 900 MHz in male Hsd:Sprague Dawley SD rats based on the incidences of malignant schwannoma of the heart. The incidences of malignant glioma of the brain and benign, malignant, or complex pheochromocytoma (combined) of the adrenal medulla were also related to RFR exposure. The incidences of benign or malignant granular cell tumors of the brain, adenoma or carcinoma (combined) of the prostate gland, adenoma of the pars distalis of the pituitary gland, and pancreatic islet cell adenoma or carcinoma (combined) may have been related to RFR exposure. There was *equivocal evidence of carcinogenic activity* of GSM-modulated cell phone RFR at 900 MHz in female Hsd:Sprague Dawley SD rats based on the incidences of schwannomas of the heart.

Increases in nonneoplastic lesions of the heart, brain, and prostate gland in male rats, and of the heart, thyroid gland, and adrenal gland in female rats occurred with exposures to GSM-modulated RFR at 900 MHz.

CDMA-Modulated RFR

Under the conditions of this 2-year whole-body exposure study, there was ***clear evidence*** *of carcinogenic activity* of CDMA-modulated cell phone RFR at 900 MHz in male Hsd:Sprague Dawley SD rats based on the incidences of malignant schwannoma of the heart. The incidences of malignant glioma of the brain were also related to RFR exposure. The incidences of adenoma of the pars distalis of the pituitary gland and adenoma or carcinoma (combined) of the liver may have been related to RFR exposure. There was *equivocal evidence of carcinogenic activity* of CDMA-modulated cell phone RFR at 900 MHz in female Hsd:Sprague Dawley SD rats based on the incidences of malignant schwannoma of the heart, malignant

glioma of the brain, and benign, malignant, or complex pheochromocytoma (combined) of the adrenal medulla.

Increases in nonneoplastic lesions of the heart, brain, and prostate gland in male rats, and of the brain in female rats occurred with exposures to CDMA-modulated RFR at 900 MHz.

* Explanation of Levels of Evidence of Carcinogenic Activity is on page 16. A summary of the Peer Review Panel comments and public discussion on this Technical Report appears in Appendix L.

(pp. 125-126.) (Underlining and emphasis added.)

[NTP final report - End quote]

EXHIBIT 24L (FD):

Long-Term Exposure to Microwave Radiation Provokes Cancer Growth: Evidences from Radars and Mobile Communication Systems. I. Yakymenko[1,2]*, E. Sidorik[1], S. Kyrylenko[3], V. Chekhun[1] [1]R.E. Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology of National Academy of Sciences of Ukraine; [2]Bila Tserkva National Agrarian University, Ukraine; [3]Masaryk University, Kamenice, Czech Republic. Experimental Oncology 2011 33, 2, 62-70. Reads in part:

[Microwave radiation provokes cancer growth - Begin quote]

We strongly suggest that in the forthcoming epidemiological studies the correct measurement of intensity and dosage of exposure should be obligatory. The example of a large-scale epidemiological research employing personal MW dosimeters can be found in recent studies in Germany [91—94]. On the other hand, we also realize that **the levels of the MW exposure in contemporary epidemiological studies, at least in those which deal with mobile communication systems, were within the official "safety limits" set by appropriate national standards and ICNIRP recommendations**. Therefore, taking into account the reviewed data, **we conclude that the relatively long-term (e.g., 10 years) exposure to microwaves emitted from mobile communication devices operating within "safety limits" set by current regulating bodies can be considered as a potential factor for promotion of cancer growth**. Indeed, **in the most studies on rodents the intensity of MW exposure was appropriately measured, and in majority of them the MW intensity was below ICNIRP safety limits. Nevertheless, majority of these studies to a greater or lesser extent demonstrated obvious carcinogenic effects after long term exposure (up to 24 months)**. This further emphasizes that at least under certain conditions **the**

exposure to both pulsed and continuous MW with intensities below the current official 'safety limits' can indeed promote cancer development.

In addition, **experimental evidences of involvement of typical markers of carcinogenesis like overproduction of reactive oxygen species or formation of 8-OH-dG under conditions of MW exposure further indicate potential danger of this type of radiation for human health**. It is important to emphasize here that **experimental data, especially obtained in studies *in vitro* often reveal significant biological effects even after short-term (e.g., only a few minutes)** [72] **and/or extremely weak intensity of exposure to MW (by several orders of magnitude lower than in ICNIRP recommendations)** [95]. Taking these data into account we strongly suggest that currently used "thermal" assessment of potential hazards of MW exposure is far from being appropriate and safe.

Taken together, we state here that **nowadays there is enough convincing data to appropriately assert that the long-term exposure to low intensity electromagnetic microwaves can indeed promote cancer development**. To that, the official recommendations by ICNIRP and safety limits set by many national regulatory bodies for technical devices emitting microwave radiation, first of all for mobile communication systems, must be re-assessed according to the recent alarming data; and additional studies for unprejudiced risk assessment must be carried out. **At present, we strongly suggest for a wide implementation of precautionary principle for everyday microwave exposure that implies maximum restriction of excessive exposure**.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

[Microwave radiation provokes cancer growth - End quote]

EXHIBIT 24N (FD):
Probabilistic Multiple-Bias Modeling Applied to the Canadian Data From the Interphone Study of Mobile Phone Use and Risk of Glioma, Meningioma, Acoustic Neuroma, and Parotid Gland Tumors. F. Momoli, et al. American Journal of Epidemiology, Vol. 186, No. 7. May 23, 2017. DOI: 10.1093/aje/kwx157. Reads in part:

"When comparing the highest quartile (>558 hours) of cumulative hours of use (second and third quartiles collapsed) with the reference category, the **odds ratio for glioma was 2.0 (95%CI: 1.2, 3.4)**." (Emphasis added.)

EXHIBIT 25 (FD):
Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Falcioni, L., et al., **Ramazzini Institute**. Environmental Research https://doi.org/10.1016/j.envres.**2018**.01.037. **This study also reported tumors of the brain and heart, but at much lower SAR levels**. The study report reads in part:

The Ramazzini Institute "findings on far field exposure to RFR are consistent with and **reinforce the results of the NTP study** on near field exposure, as both reported an increase in the incidence of tumors of the brain and heart in RFR-exposed Sprague-Dawley rats. **These tumors are of the same histotype of those observed in some epidemiological studies on cell phone users**. These experimental studies provide sufficient evidence to call for the reevaluation of IARC conclusions regarding the carcinogenic potential of RFR in humans." (Underlining and emphasis added.)

EXHIBIT 44G (FD):
Genotoxic and carcinogenic effects of non-ionizing electromagnetic fields. A. Kocaman, G. Altun, A. Kaplan, O. Deniz, K. Yurt, S. Kaplan. Environmental Research 163 (2018) 71-79. Reads in part:

"It is well documented that EMF exposure might cause indirect harmful effects *via* DNA damage, and DNA breaks, and oxidative stress. ... [I]n the light of the information gathered in this study, EMF shows its biological effects by acting indirectly on cellular fragments. Long-term disruption of hemostasis may lead to the disruptive effects of EMF. Furthermore, it should not be forgotten that EMF is energy and EMF may show entropy-accelerating effects on every object present in the environment."

5. Exhibits and Partial Transcripts of Letters, Reports and Presentations Authored by Highly-credentialed Research Scientists, Medical Doctors, and Professional Medical and Scientific Organizations

This section includes the following:

Exhibit Nos. 1A, 1K, 4I, 8, 9A, 9C-1, 9C-2, 10, 11A, 11B, 12, 15, 17A, 18A, 18B, 18C, 18D, 19C, 19D, 19E, 19F, 19G, 20A, 20D, 21A-2, 21A-3, 21A-4, 21B-14, 21B-15, 21B-16, 21B-17, 21C-3, 21C-5, 21D-1, 21D-2, 21F, 21J, 21K, 21L, 22A, 24A, 24B-1, 24B-2, 24C-1, 24C-2, 24C-3, 24D-1, 24D-2, 24D-3, 24E, 24F, 24G,

24H, 24J, 26, 27, 29A, 29B, 29C-1, 29C-2, 29C-3, 29C-4, 29C-5, 29C-6, 29C-6A, 29C-7A, 29C-7B, 29C-8, 29C-9, 29C-10, 29C-11, 29C-12, 29C-13, 29C-14, 29C-16, 29C-17, 29C-18, 30A, 30B, 30C, 30D, 30E, 31D, 31E, 32A, 32B, 32C, 32D, 33A, 33B, 33C, 33D, 33E, 34B, 34C-1, 34D, 35, 36A, 37, 39A, 39B, 40, 41, 42A-1 through 42I (especially Exhibits 42A-1, 42B-1, 42B-2, 42E, 42G, 42H, and 42I), 43A, 43B, 43C, 43D, 43E, 43F, 43G, 44A through 44N (especially Exhibits 44E-2, 44J, 44K, 44L-1, and 44L-2), 45C, 45C-1, 45M, 45N, 45O, 45P, 45Q, 45R-1, and 45R-2.

All of the exhibits listed within this section constitute directly relevant and highly credible evidence of completely reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

Because Dr. Martin Blank, PhD, the declarant in Exhibit 34B is deceased, his testimony in this exhibit constitutes and can be received as credible, competent and substantial evidence under the provisions of Pa.R.E. 804(a)(4).

Dr. Martha Herbert, PhD, MD, the declarant in Exhibit 21F, was accepted as an expert witness in the federal Civil Action No. 4:15-CV-40116-TSH, "G ... v. the Fay School," 282 F.Supp.3d 381 (2017), involving allegations of adverse health effects of exposure to radiofrequency radiation.

EXHIBIT 1A (FD):
Lawrence McKnight, MD, *petition to Pennsylvania Governor Wolf, Attorney General Shapiro, the Pennsylvnaia Public Utility Commission and Commonwealth Legislators*.

Dr. McKnight's petition states in part: "For people with electromagnetic sensitivity, exposure to AMI meters is similar to a person with an adverse reaction to particular foods or medicines. While a substance can be safe for some people, for others it is just not. But, unlike a person with a peanut allergy who can choose not to eat peanuts, people with electrical sensitivity have no choice. Beyond the challenges they face in public places, they cannot even seek sanctuary in their own homes. ... Act 129 is literally as silly as a law *requiring* all persons to be exposed to peanuts despite a person with a documented peanut allergy."

Pages 12 through 19 of this petition contain summaries of various cases of persons with EHS (electro-hypersensitivity syndrome) that have been brought before the Pennsylvania Public Utility Commission.

In the case of Dr. A.M., the Administrative Law Judge "ruled that Dr. A. M. **will be adversely affected by reinstallation of a *Landis + Gyr* smart meter, and re-installation of a *Landis + Gyr* smart meter would constitute unsafe**

or unreasonable service in violation of 66 Pa. C.S. § 1501." (See *Alexia McKnight v. PECO Energy Company*, Docket No. C-2017-2621057.) (Underlining, italics and emphasis added.)

In the case of M.P., the same judge concluded that "**The preponderance of the evidence does suggest that some other aspect of the Peco smart meters is** inimitably perceptible by and **contrary to the health and well-being of the individual**, Ms. Povacz." (*Maria Povacz v. PECO Energy Company*, Docket No. C-2012-2317176.) (Underlining, italics and emphasis added.)

EXHIBIT 1K (FD):
Electromagnetic and Radiofrequency Fields Effect on Human Health. American Academy of Environmental Medicine. Reads in part:

"[M]any *in vitro, in vivo* and epidemiological studies demonstrate that significant harmful biological effects occur from non-thermal RF exposure and satisfy Hill's criteria of causality.[3] Genetic damage, reproductive defects, cancer, neurological degeneration and nervous system dysfunction, immune system dysfunction, cognitive effects, protein and peptide damage, kidney damage, and developmental effects have all been reported in the peer-reviewed scientific literature." (p. 2.) ([3]Hill, AB. The Environment and Disease: Association or Causation? Proceedings of the Royal Society of Medicine. 1965; 58: 295-300.)

"Electromagnetic field (EMF) hypersensitivity has been documented in controlled and double blind studies with exposure to various EMF frequencies. Rea *et al*. **demonstrated that under double blind placebo controlled conditions, 100% of subjects showed reproducible reactions to that frequency to which they were most sensitive**. Pulsed electromagnetic frequencies were shown to consistently provoke neurological symptoms in a blinded subject while exposure to continuous frequencies did not." (p. 3.) (Underlining and emphasis added.)

EXHIBIT 4I (FD):
Letter, dated August 29, 2013, from the American Academy of Pediatrics to the Commissioner and Acting Commissioner of the Federal Communications Commission (FCC).
https://ecfsapi.fcc.gov/file/7520941318.pdf

Reads in part:

"Current FCC standards do not account for the unique vulnerability and use patterns specific to pregnant women and children. It is essential that any new standard for cell phones or other wireless devices be based on protecting the

youngest and most vulnerable populations to ensure they are safeguarded throughout their lifetimes."

...

"The current metric of RF exposure available to consumers, the Specific Absorption Rate, is not an accurate predictor of actual exposure. AAP is supportive of FCC developing standards that provide consumers with the information they need to make informed choices ... ."

EXHIBIT 8 (FD):

Scientific evidence ... microwaves act through voltage-gated calcium channel activation to induce biological impacts ***at non-thermal levels***. Martin L. Pall. Rev Environ Health 2015; 30(2): 99–116.

EXHIBIT 9A (FD):

Dr. Martin L. Pall letter to California legislature. Reads in Part: "Thousands of published studies show biological and health effects from electromagnetic fields. We now know the mechanism that can explain these effects. The mechanism is a function of the electromagnetics of each cell—not solely about heating effects from the radiation (on which present FCC guidelines are based). ... According to industry, the forces electromagnetic fields place on electrically charged groups in the cell are too weak to produce biological effects. However, the unique structural properties of the voltage-gated calcium channel (VGCC) protein can, it turns out, explain why the force on a cell's voltage sensor from low-intensity EMFs are ***millions of times stronger*** than are the forces on singly-charged groups elsewhere in the cell. ... Legislators would best pause to understand the gravity of the biological effects, and the ramifications for physical and mental health, as well as consequences from continual damage to human DNA, and learn the facts from scientists who are independent of the wireless industry, not from the industry lobbyists who have a gigantic conflict of interest." (Underlining and italics added.)

EXHIBIT 9C-1 (FD):

Overview of compelling evidence of adverse biological effects of radiofrequency radiation presented by Dr. Martin Pall, PhD.

EXHIBIT 9C-2 (FD):

Compelling Evidence for Eight Distinct Types of Great Harm Caused by Electromagnetic Field (EMF) Exposures and the Mechanism that Causes Them. Dr. Martin Pall, PhD.

EXHIBIT 10 (FD):
Electromagnetic Field Exposure—The Cellular Effect on Humans. Dr. Martin L. Pall, PhD. Detailed presentation of *explanatory mechanism* by which electromagnetic fields cause cellular and sub-cellular adverse biological effects in humans.

EXHIBIT 11A
How Smart Meters May Cause Autism and Cancer. Dr. Andrew Goldsworthy, PhD, Lecturer in Biology, Imperial College, London. Reads in part:

"[P]resent safety guidelines ... were drawn up on the assumption that the radiation could only damage living tissues if it generated significant heat. It has since been shown that radiation at much lower levels has direct electrical effects.

"These are mainly on electrically charged cell membranes, where the low frequency pulses from the modulated microwaves make them vibrate and leak. ... Modulated microwaves, such as those from cell phones, portable phones, WiFi, baby monitors and wireless smart meters are sources of potentially damaging radiation. The strength of the radiation appears to be less important than the duration and pattern of the exposure, with intermittent and repeated exposure being the most damaging. The strong regular transmissions from wireless smart meters are particularly harmful and more likely to lead to DNA damage, cancer and autism.

"Sub-thermal effects of electromagnetic radiation.
There are thousands of scientific papers showing biological effects of non-ionizing electromagnetic radiation occurring well below the levels at which they can generate significant heat. ... They include harmful effects such as damage to DNA in living cells that can lead to cancer, loss of fertility, brain damage due to the disruption of the blood-brain barrier and neuronal hyperactivity leading to autism in children. Many of these effects can be attributed to the loss of structurally important calcium from cell membranes, which makes them leak. This can disrupt normal metabolism and also release DNase (which destroys DNA) from the internal structures (lysosomes) that normally recycle waste into the rest of the cell.

"Prolonged and intermittent radiation causes more damage
The duration of the radiation seems to be more important than its strength, with the effects being cumulative as more and more cells are damaged. Interestingly, DNA damage from cell phone radiation is greater when the exposure is intermittent (5 minutes on, 10 minutes off) than when continuous (Diem et al 2005). ... Diem et al.

(2005) also found that the effect on DNA damage was still greater if the microwaves were pulsed or modulated to carry information (modulation involves sudden stops and starts of the signal, which are even more damaging). Smart meters, which operate 24/7 and radiate modulated microwaves intermittently, can therefore be expected to be particularly harmful to DNA.

"Microwave radiation causes cancer

There is already evidence that heavy cell phone users are more prone to brain cancers. This has resulted in cell phones now being rated by the World Health Organisation as class 2B carcinogens. This rating may later be increased, since brain tumours normally take decades to develop and few people have been regularly using a cell phone for more than a single decade. Particularly worrying is the finding by Hardell and Carlberg (2009) that young people were about 5-times more likely to get brain cancer both from cordless and cell phones if they began using them before the age of 20. The regular transmissions from wireless smart meters can be expected to have much the same effect, with younger people being more at risk. This is possibly because their brain structure is still growing and developing and therefore more susceptible to damage leading to cancer.

"Non-ionising radiation makes cell membranes leak

The first effect of non-ionising electromagnetic radiation is to generate small alternating voltages across the cell membranes, which destabilize them and make them leak. This can have all sorts of consequences as unwanted substances diffuse into and out of cells unhindered, and materials in different parts of the cell that are normally kept separate, become mixed.

"Why weak fields are more damaging than strong ones

We have known since the work of Suzanne Bawin and her co-workers (Bawin et al. 1975) that modulated radio-frequency electromagnetic radiation that is far too weak to cause significant heating can nevertheless remove calcium ions (positively charged calcium atoms) from cell membranes in the brain. ... A proposed molecular mechanism for this can be found in Goldsworthy (2010). In particular, it explains why weak electromagnetic fields can have a greater effect than strong ones and why prolonged exposure to weak fields (where cells are maintained in the unstable condition for longer) is potentially more damaging than relatively brief exposure to much stronger ones.

"How calcium ions stabilize cell membranes

This loss of calcium is important because calcium ions bind to and stabilize the negatively charged membranes of living cells. They sit between the negatively charged components of the cell membrane and bind them together rather like mortar binds together the bricks in a wall. Loss of just some of these calcium ions destabilize the membrane and make it more inclined to leak, which can have

serious metabolic consequences. Among these are the effects of membrane leakage on the neurons of the brain.

"How membrane leakage affects neurons
Neurons transmit information between one another in the form of chemical neurotransmitters that pass across the synapses where they make contact. However, the release of these is normally triggered by a brief pulse of calcium entering the cell. If the membrane is leaky due to electromagnetic exposure, it will already have a high internal calcium concentration as calcium leaks in from the much higher concentration outside. The effect of this is to put the cells into hair-trigger mode so that they are more likely to release neurotransmitters and the brain as a whole may become hyperactive (Beason and Semm 2002; Krey and Dolmetsch 2007, Volkow et al. 2011). This may not be a good thing since the brain may become overloaded leading to a loss of concentration and what we now call attention deficit hyperactive disorder (ADHD)." (Underlining added.)

EXHIBIT 11B (FD):
Brief commentary by Dr. David Carpenter, Director of the Institute for Health and Environment, University at Albany School of Public Health, State University of New York, on the *complete and utter lack of evidence that smart meters are safe*. Dr. Carpenter avers that, in stark contrast, there is an abundance of evidence "that 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, ... has adverse reproductive effects, and a variety of other effects on different organ systems."

EXHIBIT 12 (FD):
Wireless Radiofrequency Radiation in Schools. American Academy of Environmental Medicine. Public announcement of the American Academy of Environmental Medicine reads in part: "The peer reviewed, scientific literature demonstrates the correlation between RF exposure and neurological, cardiac, and pulmonary disease as well as reproductive and developmental disorders, immune dysfunction, cancer and other health conditions. **The evidence is irrefutable**." (Underlining and emphasis added.)

EXHIBIT 15 (FD):
Effects of Cellular Phone Radiation. Dr. Leif G. Salford. Dr. Salford presents his research team's findings which show the surprising degree of blood-brain barrier leakage and damage to the brains of rats that occurred within a very short period of

time and from unexpectedly long distances as a result of the rats' exposure to low-level cell phone RF radiation. The introduction reads in part:

"Since 1988, Dr. Salford and a team of researchers have exposed thousands of rats to microwave radiation. Their results have found that: Not only does the radiation damage the blood brain barrier, but it does so even at much lower levels than a cell phone. A single 2-hour exposure to a cell phone, even at reduced power, was shown to damage or destroy up to 2% of an animal's brain cells. These animals also experienced memory impairment, genetic damage, and other biological effects."

EXHIBIT 17A (FD):
Radiofrequency and Extremely Low-Frequency Electromagnetic Field Effects on the Blood-Brain Barrier. Dr. Leif G. Salford, MD, PhD, et al. Electromagnetic Biology and Medicine, 27: 103–126, 2008.

EXHIBIT 18A (FD):
Use of Wireless Phones and Evidence for Increased Risk of Brain Tumors. Lennart Hardell, MD, PhD, Associate Professor, Department of Oncology and Michael Carlberg, MSc, Department of Oncology, University Hospital, Örebro, Sweden (November 2017). One of two epidemiological case-control studies which resulted in more information input for the IARC evaluation, showing that the risk to develop brain tumors and vestibular Schwannoma was increased in people with the highest cumulative use of mobile phones, in people who had used mobile phones on the same side of the head as that on which their tumor developed, and in people whose tumor was in the temporal lobe of the brain (the area of the brain that is most exposed to RFR when a wireless phone is used at the ear). Reads in part:

"By now **carcinogenicity has been shown in human epidemiological studies replicated in animal studies. Laboratory studies on RF radiation have shown increased ROS production that can cause DNA strand breaks.** In 2013, **we published the conclusion that RF radiation should be regarded as a human carcinogen Group 1 according to IARC definition, based on scientific evidence** (Hardell and Carlberg, 2013) further supported in our up-dated article (Carlberg and Hardell, 2017)

"Clearly also based on the IARC preamble to the monographs, RF radiation should be classified as 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.'

"(*http://monographs.iarc.fr/ENG/Preamble/currentb6evalrationale0706.php)*"
(Emphasis added.)

EXHIBIT 18B (FD):
Evaluation of Mobile Phone and Cordless Phone Use and Glioma Risk Using the Bradford Hill Viewpoints from 1965 on Association or Causation. Michael Carlberg and Lennart Hardell. BioMed Research International, Volume 2017, Article ID 9218486, https://doi.org/10.1155/2017/9218486. In this evaluation, Dr. Hardell also addresses the issue of industry influence and conflicts of interest among various international bodies charged with assessing safety and establishing standards for radiofrequency radiation. Of particular note is the fact 5 of 6 members of the WHO Monograph core group are also members of ICNIRP. Reads in part:

"No doubt the IARC decision started a worldwide spinning machine to question the evaluation, perhaps similar to the one launched by the tobacco industry when IARC was studying and evaluating passive smoking as a carcinogen in the 1990s [16]. Sowing confusion and manufacturing doubt is a well-known strategy used by the tobacco and other industries [17–19]; see also Walker [20]."
...
"ICNIRP is a private organization (NGO) based in Germany that selects its own members. Their source of funding is not declared. IEEE is the world's most powerful federation of engineers. The members are or have been employed in companies or organizations that are producers or users of technologies that depend on radiation frequencies, such as power companies, the telecom industry, and military organizations. IEEE has prioritized international lobbying efforts for decades especially aimed at the WHO."
...
"There are a vast number of scientific articles that show nonthermal adverse health effects from RF radiation."
...
"The guideline in the BioInitiative Report obviously contradicts the one proposed by ICNIRP. The ICNIRP exposure level has been vigorously propagated by that organization in order to harmonize guidelines worldwide. With few exceptions it has been a successful story and most countries have adopted the ICNIRP guideline. This gives a "green card" to roll out the technology with increasing RF radiation exposure to the population, for example, using wireless Internet access in schools [28], since the high exposure level in the guideline by ICNIRP is rarely compromised. Thus, the exposure target level in the BioInitiative Report is not

acknowledged by, for example, the Swedish Radiation Safety Authority (SSM). Many persons at the SSM expert panel are also members of ICNIRP which might be a conflict of interests since they would rarely compromise the ICNIRP view; critical opinions are not heard. As a matter of fact the Ethical Board at the Karolinska Institute in Stockholm, Sweden, concluded already in 2008 that being a member of ICNIRP may be a conflict of interests that should be stated in scientific publications (Karolinska Institute Diary Number 3753-2008-609), which is however not done to our knowledge.

"An association between use of wireless phones and glioma has not been acknowledged by several scientific bodies in spite of the IARC classification in May 2011. This is exemplified below. In fact, as can be seen in Table 1 the same persons may appear in different expert groups. This would hardly make any substantial difference in the opinion between these groups. They may in fact cite themselves by claiming that various organizations have come to similar conclusion. It is striking how ICNIRP has infiltrated the WHO Monograph core group making it less likely that the conclusions in that Monograph will differ from ICNIRP's conclusions."

Table 1: Members of WHO Monograph core group and their involvement in different other groups.

Name	WHO	ICNIRP	UK/AGNIR	SSM	SCENIHR
Simon Mann	**X**	**X**	**X**		
Maria Feychting	**X**	**X**	**X**	**X***	
Gunnhild Oftedal	**X**	**X**			
Eric van Rongen	**X**	**X**		**X**	
Maria Rosaria Scarfi	**X**	**X***		**X**	**X**
Denis Zmirou	**X**				

* **Former**
WHO: World Health Organization.
ICNIRP: International Commission on Non-Ionizing Radiation Protection.
AGNIR: Advisory Group on Non-Ionising Radiation.
SSM: Strålsäkerhetsmyndigheten (Swedish Radiation Safety Authority).
SCENIHR: Scientific Committee on Emerging and Newly Identified Health Risks.

EXHIBIT 18C (FD):

Cell Phone Radiation, Cancer and Science. Dr. Lennart Hardell, MD, PhD. Presentation of scientific evidence, including epidemiologic, animal and mechanistic studies of cancer as an effect of exposure to radiofrequency radiation from cell phones. Beginning at the 5:52 minute-mark, Dr. Hardell displays data results of **Interphone**, **NTP**, and **Ramazzini Institute** studies, which show significant increases in risk of cancer from exposures to RF radiation from cell phones while also showing a consistency between epidemiological and animal studies. Beginning at the 8:56 minute-mark, Dr. Hardell points to the **mechanisms**, including voltage-gated calcium channels (VGCC), elucidated by the research of

Dr. Martin Pall, and reactive oxygen species (ROS), both of which, now much more understood, can explain in a unified way the many biological effects of RF radiation exposure.

EXHIBIT 18D (FD):
Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen. Devra Lee Davis, Santosh Kesari, Colin L. Soskolne, Anthony B. Miller, Yael Stein. Pathophysiology 20 (2013) 123–129.

EXHIBIT 19C (FD):
Non-Thermal Effects and Mechanisms of Interaction Between Electromagnetic Fields and Living Matter. (ICEMS). Ramazzini Institute. European Journal of Oncology Library, Vol. 5. Compilation of articles organized according to four basic categories of research: "Biophysical Mechanisms", "Cellular Mechanisms and Tissue Effects", "In Vivo Effects", and "Epidemiology". On pp. 51-61, among the articles pertaining to biophysical mechanisms is the following article:

Weak low-frequency electromagnetic fields are biologically interactive, Dr. Abraham R. Liboff, PhD, Center for Molecular Biology and Biotechnology, Florida Atlantic University. This article reads in part:

"Current thinking relies on simplistic electrical engineering estimates completely at odds with reliable scientific findings. Recent studies add to the already abundant evidence indicating that ultra-weak low- frequency electromagnetic fields are biologically interactive."
...
"Nonetheless, there has been no recognition by WHO, ICNIRP or other standards–setting agencies of the
evidence demonstrating the interactive capability of low frequency fields with biological systems."
...
"It is critical that epidemiologists, especially, understand the strength of this empirically based biological evidence. Future studies must avoid being designed around inapplicable assumptions, chiefly those that define a lower limit for biological interactions and those maintaining that more intensity is worse."
...
"**The wealth of observations listed above make it difficult to avoid concluding that low level time-varying magnetic fields at power line frequencies are specifically interactive with biological systems, including humans**. Further, the discovery by Zhadin's group and subsequent replications make it clear that ultra

small AC magnetic intensities, down to 50 nT, falls into this interactive category." (Emphasis added.)

EXHIBIT 19D (FD):
The Biological Effects of Weak Electromagnetic Fields. Dr. Andrew Goldsworthy, PhD.
https://ecfsapi.fcc.gov/file/7022311211.pdf Page 6 reads in part:

Cells have tremendous powers to amplify and respond to weak signals
We now know that electromagnetic growth stimulation is almost certainly due to electrochemical amplification followed by the activation of the MAP kinase cascades by free calcium ions leaking into the cytosol (the main part of the cell). The inward leakage of calcium ions is the normal mechanism by which a cell senses that it has been damaged and triggers the necessary repair mechanisms. This involves huge amplification processes so that even minor leakage (e.g. due to membrane perforation or weak electromagnetic fields) can give rapid and often massive responses.

The first stage in the amplification is due to the calcium gradient itself. There is an enormous (over a thousand fold) concentration difference for free calcium between the inside and outside of living cells. In addition, there is a voltage difference of many tens of mV acting in the same direction. This means that even a slight change in the leakiness of the cell membrane can permit a very large inflow of calcium ions. It's like a transistor, where a slight change in the charge in the base can allow a massive current to flow through it under the influence of a high voltage gradient between the emitter and collector.

The next stage in the amplification is due to the extremely low calcium concentration in the cytosol so that even a small ingress of calcium ions makes a big *percentage* difference, to which many enzymes within the cell are sensitive.

Even more amplification comes from the MAP-kinase cascades. These are biochemical amplifiers that enable tiny amounts of growth factors or hormones (perhaps even a single molecule) to give very large effects. They consist of chains of enzymes acting in sequence so that the first enzyme activates many molecules of the second enzyme, which in turn activates still more of the third enzyme etc. The final stage then activates the protein synthesising machinery needed for cell growth and repair.

At least some of these cascades need calcium ions to work (Cho *et al.* 1992) so the inward leakage of calcium through damaged cell membranes will increase the rate of these processes to stimulate growth and repair. However, these repairs can make

deep inroads into the cell's energy and resources, and its ability to make good the damage will depend on its physiological and nutritional condition. This means that, if the damage is prolonged or persistent, sooner or later it runs out of resources and gives up, which is when we see the inhibitory phase, perhaps followed by apoptosis (cell death) or the loss of some of the cell's normal functions. **We are now seeing this loss of function increasingly after prolonged human exposure to cell phone base station radiation; e.g. the loss of thyroid gland function after six years of exposure (Eskander *et al*. 2012)**. (Emphasis added.)

EXHIBIT 19E (FD):
International Encyclopedia of Neuroscience - *Electromagnetic fields, the modulation of brain tissue functions — A possible paradigm shift in biology*. Dr. W. Ross Adey, MD, Distinguished Professor of Physiology, Loma Linda University School of Medicine. https://ecfsapi.fcc.gov/file/7521096402.pdf Reads in part:

"**Heating models**, based in equilibrium thermodynamics, **fail to explain a wide spectrum of observed nonthermal EMF bioeffects in central nervous tissue**. The findings suggest a biological organization based in physical processes at the ***atomic level***, beyond the realm of chemical reactions between biomolecules." (Underlining, italics and emphasis added.)

EXHIBIT 19F (FD):
Cell phone radiation exposure on brain and associated biological systems. Kavindra Kumar Kesari, Mohd. Haris Siddiqui, Ramovatar Meena, H N Verma & Shivendra Kumar. Indian Journal of Experimental Biology, Vol.51, March 2013, pp. 187-200.

EXHIBIT 19G (FD):
Graphic excerpted from EXHIBIT 19F detailing pathways of effects in the brain and associated biological systems from exposure to cell phone radiation. Increase in reactive oxygen species (ROS) is identified as a mechanism in the processes leading to RFR-induced DNA strand breaks among other biological effects.

EXHIBIT 20A (FD):
Can cell phone use cause cancer?: Genetic effects of radiofrequency fields. Dr. Henry Lai, PhD, Research Professor, Department of Bioengineering, University of Washington. Visual ***comet assay*** evidence of DNA damage caused by **non-ionizing**, radiofrequency radiation exposure. Discussion of *comet assay* begins at 3:42. Visual display of *Comet Assay* result begins at 5:19. Dr. Lai displays a listing

of peer-reviewed publications on genetic effects of radiofrequency fields, beginning at 6:53. (See also **EXHIBIT 24K**.)

EXHIBIT 20D (FD):
Electromagnetic Fields and DNA Damage. J.L. Phillips, N.P. Singh, H. Lai, Pathophysiology 16 (2009) 79–88. Reads in part:

"The lack of a causal or proven mechanism(s) to explain RFR-induced effects on DNA damage and repair does not decrease the credibility of studies in the scientific literature that report effects of RFR exposure, because there are several plausible mechanisms of action that can account for the observed effects. The relationship between cigarette smoking and lung cancer was accepted long before a mechanism was established. This, however, occurred on the strength of epidemiologic data [99]. Fortunately, relevant epidemiologic data relating long-term cell phone use (>10 years) to central nervous system tumors are beginning to appear [84,100–102], and these data point to an increased risk of acoustic neuroma, glioma and parotid gland tumors."
...
"RFR exposure does indeed appear to affect DNA damage and repair, and the total body of available data contains clues as to conditions producing effects and methodologies to detect them. This view is in contrast to that of those who believe that studies unable to replicate the work of others are more credible than the original studies, that studies showing no effects cancel studies showing an effect, or that studies showing effects are not credible simply because we do not understand how those effects might occur."

EXHIBIT 21A-2 (FD):
Cell phones and brain tumors: A review including the long-term epidemiologic data. Vini G. Khurana, PhD, FRACS, Charles Teo, MBBS, FRACS, Michael Kundi, PhD, Lennart Hardell, MD, PhD, Michael Carlberg, MSc. Surgical Neurology, 10.1016/j.surneu.2009.01.019).

EXHIBIT 21A-3 (FD):
Mobile Phones and Brain Tumours: A Public Health Concern (Dr. Vini G, Khurana, PhD.)

EXHIBIT 21A-4 (FD):

Renowned neurosurgeon, Dr. Charles Teo, calls for the right to know about the potential dangers of cell phone radiation. Presentation given at University of New South Wales Law School, November 18, 2015.

EXHIBIT 21B-14 (FD):
Harmful Effects of Wireless. In-depth, 2019 interview of Dr. Paul Heroux, PhD. (Dr. Heroux's academic and professional credentials are stated in the interview and also appear elsewhere in the text of this Brief.) Beginning at the 01:35 minute-mark of this interview, Dr. Heroux very succinctly and eloquently addresses the 'fake science' strategy and tactics of obfuscation used by the wireless industry to escape regulation by continually 'raising the bar' and demanding that science provide complete explanations of the mechanisms underlying biological effects of RF radiation exposure. Dr. Heroux asserts that the cellular and sub-cellular mechanisms which explain many of the biological effects of RF are better understood scientifically than the mechanisms of action of many drugs that have been approved and are on the market.

EXHIBIT 21B-15 (FD):
*Science on Wireless Radiatio*n. In-depth, 2019 interview of Dr. Devra Davis, PhD, MPH. (Dr. Davis's academic and professional credentials are stated in the interview and also appear elsewhere in the text of this Brief.) In this interview, Dr. Davis also exposes the wireless industry playbook and discusses the findings of science which are strenuously being suppressed by the anti-scientific strategy and tactics of wireless industry activism.

EXHIBIT 21B-16 (FD):
Explaining the Mechanism of Wireless Harm. In-depth, 2019 interview of Dr. Martin Pall, PhD. (Dr. Pall's academic and professional credentials are stated in the interview and also appear elsewhere in the text of this Brief.) Beginning at the 02:08 minute-mark of this interview, Dr. Pall discusses scientific evidence firmly supporting the reasons why the existing government 'safety guidelines' utterly fail to provide an adequate standard of protection from non-thermal levels of exposure to RF radiation. Beginning at the 03:21 minute-mark, Dr. Pall outlines nine (9) key areas of biomedical research in which biological effects of RF radiation exposure have been shown by peer-reviewed studies in the scientific literature. Dr. Paul then discusses, beginning at the 12:36 minute-mark, eight (8) specific areas in which there is extensive, repeated evidence that government "safety guidelines" do not predict biological effects and therefore do not predict safety. Accordingly, the current FCC guidelines are insufficient as standards of protection from non-thermal levels of exposure to RF radiation. These eight areas include:

(1) the vast body of science demonstrating harm;
(2) pulsed EMFs are more dangerous;
(3) known, scientifically explained mechanisms, such as voltage-gated calcium channels (VGCCs),
are not acknowledged or taken into account;
(4) effects from single, nanosecond pulses;
(5) effects from pairs of nanosecond pulses;
(6) the existence of "exposure intensity windows";
(7) variation of effects, depending on cell type;
(8) certain RF frequencies produce effects which are vastly greater in magnitude.

EXHIBIT 21B-17 (FD):
Lecture at the Edmond J. Safra Center for Ethics of the Harvard Law School presented by Dr. Franz Adlkofer, MD, entitled: *The exposure limits supposed to protect people from radiofrequency radiation are the result of institutional corruption*. November 3, 2011. Extended March 16, 2012. Two of Dr. Adlkofer's research studies that showed DNA breakage resulting from exposure to radiofrequency radiation were alleged by the wireless industry to be fraudulent, and Dr. Adlkofer was charged with professional misconduct. After years of investigation, his research results held up to scientific scrutiny, and he finally was exonerated. His Harvard lecture reads in part:

"According to the IARC panel the results of epidemiological studies had been decisive for the 'possibly carcinogenic' classification. These studies observed after long-term (>10 years) and intensive use of cell phones an increased risk for brain tumors exactly at the side of the head at which the cell phone was held. The results from animal experiments, although of minor significance, supported the decision. **Yet, results from basic research like REFLEX that showed changes in structure and functions of genes in isolated human and animal cells as well as in living animals after exposure and that would have provided weight to the epidemiological observations were not taken into account**. **Had they been included, the classification would not have been 'possibly carcinogenic' but rather 'probably carcinogenic'**. However, it was obviously not the intention of the IARC, an organization of the WHO, to confront politics and industry that had expected a classification of 'not classifiable' with such a harsh decision. (Emphasis added.)

"The new classification is a warning shot for **the wireless communication industry** as well as for the many governments on its side. Quite obviously their **strongholds, i.e. the national and international committees that they have filled**

with hired scientists in the course of decades in order to protect their interests have been heavily damaged." (Emphasis added.)

...

"Investigations generously financed by the industry and allegedly carried out with an improved methodology usually end with a negative outcome. If the results are threatening the safety concept by attacking the exposure limits as in the case of the REFLEX data the industry obviously does not shy away from public campaigns directed against the unwanted findings and their authors. **The means are always the same: accusations of fraud and personal defamations of the authors**. **The U.S. wireless communication industry has coined the term *war gaming* for such exceptional cases**." (Emphasis added.)

...

"**The biggest dilemma is the fact that efforts by politics and industry of hiding the truth, even supported by most of the media, are successful**. **The general public has either no idea of the probably adverse effects of radiofrequency radiation or has full confidence in exposure limits that according to their governments reliably protect them**. Of course, people understandably prefer to distrust those scientists who caution against probable risks to their health, especially when their professional and moral reputation has been damaged through institutional corruption. Smear campaigns like the ones by Lerchl have certainly left their marks. The results of basic research and epidemiological studies have widely been ignored by the public, although they jointly indicate a significantly increased brain tumor risk in users of cell phones for more than ten years. With at present 5 billion cell phone users worldwide a human catastrophe is probably already under way. In democracies, it is a basic principle that above power and their owners are laws, rules, and regulations to which the owners of the power have to bow. History teaches that early warnings are far too often followed by late insights for which many people have to pay with disease and premature death. **As shown here, these rules and regulations are at present trampled underfoot by those responsible for radiation protection** ..." (Emphasis added.)

...

It is in the interest of a democratic society that it is fully informed about what is going on behind the political curtain, no matter what consequences they will draw.

EXHIBIT 21C-3 (FD):

Dangers of the Wireless Age. Dr. George L. Carlo, PhD, JD, Epidemiologist & Public Health Scientist, former Chairman, 'Wireless Technology Research' (WTR) (1990–96), and Chairman, Public Policy Institute, Washington, DC. Dr. Carlo clearly explains how radiofrequency radiation can cause damage to the human body at the cellular level. In particular, he states that it is the information-carrying radio waves which are dangerous, because it is the information carried by these waves which interact with protein sensors in cell membranes. He further explains that in

the RF cellular effect window, there is no threshold or natural protective barrier against radiofrequency radiation, meaning there is *no safe level of exposure* to information-carrying radiofrequency waves.

EXHIBIT 21C-5 (FD):
Evaluation of the Potential Carcinogenicity of Electromagnetic Fields. U.S. Environmental Protection Agency Office of Environmental and Health Assessment Office of Research and Development, October, 1990. This is the document referenced in **EXHIBIT 21C-4**, supra. The document reads in part:

"The strongest evidence that there is a causal relationship between certain forms of cancer, namely leukemia, cancer of the nervous system, and, to a lesser extent, lymphoma and exposure to magnetic fields comes from the childhood cancer studies. Several studies have consistently found modestly elevated risks (some statistically significant) of these three site-specific cancers in children. ... This is supported by the fact that children have relatively few confounding influences that could explain the association. In fact, the few potential confounders and biases that might have had an effect on the results were examined by one of the authors in some detail and found not to be a serious problem. No other agents have been identified to explain this association."
...
"**In view of all of the laboratory studies referred to in this section, there is reason to believe that the findings of carcinogenicity in humans are biologically plausible**." (Underlining and emphasis added.)
...
"In conclusion, several studies showing leukemia, lymphoma, and cancer of the nervous system in children exposed to magnetic fields from residential 60-Hz power distribution systems, supported by similar findings in adults in several occupational studies also involving electrical power frequency exposures, **show a consistent pattern of response that suggests a causal link**. **Frequency components higher than 60 Hz cannot be ruled out as contributing factors**. **Evidence from a large number of biological test systems shows that these fields induce biological effects that are consistent with several possible mechanisms of carcinogenesis**. (Underlining and emphasis added.)

EXHIBIT 21F (FD):
Children and Wireless Health Risks. Dr. Martha Herbert, MD, PhD, Harvard Medical School Director of Treatment Research and Neuroscience Evaluation of Neurodevelopmental Disorders. Dr. Herbert states in part:

"Electromagnetic fields can damage DNA, can actually cause mutations in DNA. There is also damage to proteins, such as misfolding of proteins, there's damage to cell membranes ... . There's harm to energy production in the mitochondria of the cells. Mitochondria are exquisitely vulnerable to electromagnetic field injury ... . And immune function is harmed. ... [W]e have documentation that all of these domains can be harmed by electromagnetic fields."

EXHIBIT 21J (FD):
Why children absorb more microwave radiation than adults: The consequences. L. Lloyd Morgan, Santosh Kesari, Devra Lee Davis, Journal of Microscopy and Ultrastructure 2 (2014) 197–204.

EXHIBIT 21K (FD):
Retired EPA environmental scientist states opinion, "based upon the current scientific evidence and more accumulating evidence coming," that low-level radiation can cause DNA damage and other adverse health effects, including leukemia in children. Also emphasized are the following facts:

The FCC is **not** a health agency. It is the NIH and the EPA, and **not the FCC**, which are the federal government agencies responsible for evaluating evidence and making determinations concerning biological and health effects of exposure to low-level radiofrequency radiation and electromagnetic fields.

EXHIBIT 21L (FD):
Wireless wake-up call. TEDxBerkeley presentation by Jeromy Johnson, expert in EMF exposure. Mr. Johnson, who himself suffers from electro-hypersensitivity (EHS), provides a succinct overview of the issues facing the general population due to ubiquitous exposure to RF radiation from wireless technology.

When radiofrequency radiation was classified in 2011 by IARC as a Group 2B 'possible' carcinogen, it shared this designation with lead and DDT. 'Possible', as the term is used by IARC, certainly does ***not*** mean simply that "anything can happen." Rather, the given phrase, 'possibly carcinogenic to humans', derives from **evidence** of **increased risk** of **cancer** associated with exposure to a substance or physical agent. (**EXHIBIT 22A**.)

The Group 2B, 'possibly carcinogenic to humans', designation is indicative that there is enough scientific evidence that is sufficiently strong (per **EXHIBIT 22A**) to firmly establish ***reasonable doubt*** as to the safety of a substance or physical agent with respect to its carcinogenicity.

In the case of radiofrequency radiation, the 'Group 2B' classification raised a red flag and signified that there is and/or can be an increased ***risk*** of cancer in humans associated with exposure to RFR.

Because there can be an increased ***risk*** of cancer associated with exposure to radiofrequency radiation, it is reasonable to conclude that the longer and more chronic the exposure, the greater can be the associated increase in ***risk***.

"On Tuesday, May 31 [2011], more than two dozen scientists and doctors from 14 countries — a group IARC Director Christopher Wild called "the world's leading experts — issued a joint statement that cell phone and other types of radiofrequency (RF) and microwave radiation might cause cancer." (*Microwave News*.) The IARC decision was nearly unanimous.

EXHIBIT 22A (FD):
IARC/WHO Press Release No. 208, 31 May 2011. Reads in part: "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, associated with wireless phone use. ... 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.' ... 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*." (Underlining and emphasis added.)

EXHIBIT 24A (FD):
*Commentary on the utility of the **National Toxicology Program study** on cell phone radiofrequency radiation data for assessing human health risks ...* . Ronald L. Melnick Ph.D Senior Scientist (retired), National Toxicology Program, NIEHS, NIH. Environmental Research 168 (**2019**) 1–6.

Dr. Melnick, retired Senior Toxicologist, was leader of the NTP's health effects studies of cell phone radiofrequency radiation. His recent published paper reads in part:

"[A]n expert peer review panel recently concluded that the **NTP** studies were well designed, and that the results demonstrated that both GSM- and CDMA-modulated RFR were carcinogenic to the heart (schwannomas) and brain (gliomas) of male rats. ... In conclusion, animal studies and mechanistic studies on RFR that have been published since 2011 clearly show that **the evidence on the carcinogenicity of RFR is much stronger than it was at the time of the IARC evaluation**. **If the recent animal and mechanistic findings had been available in 2011, it is likely that RFR would have been classified as a probable human carcinogen**." (Underlining and emphasis added.)

NTP/NIH cell phone RF radiation study: further commentary by Dr. Ronald Melnick, PhD, retired senior toxicologist and director of special programs in the Environmental Toxicology Program at the National Institute of Environmental Health Sciences (NIEHS), National Institutes of Health. Dr. Melnick led the design of the National Toxicology Program Carcinogenesis Studies of Cell Phone Radiofrequency Radiation in Rodents. Dr. Melnick's commentary in part:

"A recent study by the National Toxicology Program/National Institutes of Health (NTP/NIH) shows clear evidence of a causal link between cancer and exposure to wireless cell phone signals. Results from the $30 million NTP studies demonstrated that cell phone radiation caused Schwann cell cancers of the heart and brain gliomas in rats, as well as DNA damage in the brain.

"In NIH's news release, NTP senior scientist John Bucher said, 'We believe that the link between radio frequency radiation and tumors in male rats is real and the external experts agreed.'"

...

"[T]he International Agency for Research on Cancer (IARC), a part of the World Health Organization, classified radio-frequency radiation from wireless devices as a "possible human carcinogen" based largely on findings of increased risks of gliomas and Schwann cell tumors in the brain near the ear in humans after long term use of cellphones. Thus, the same tumor types are elevated in both animals and humans exposed to cell phone radiation."

...

"Simply claiming that conclusions about human risk cannot be drawn from animal studies runs counter to standard practices of evaluating human cancer risks by public health agencies including the U.S. EPA, NTP, IARC and even the FDA.

Every chemical known to cause cancer in humans is also carcinogenic in animals when adequately tested.

"The NTP studies were conducted to test the widely-held assumption that cell phone radiofrequency radiation could not cause cancers or other adverse health effects (other than by tissue heating) because this type of radiation (non-ionizing) did not have sufficient energy to break chemical bonds. **The NTP findings that cell phone radiation caused cancers in the heart and brain, DNA damage in brain cells, heart muscle disease and reduced birth weights clearly demonstrate that the assumption that non-ionizing radiation cannot cause cancer or other health effects is wrong.**" (Underlining and emphasis added.)

EXHIBIT 24B-1 (FD):
Risks: Adverse Health Impacts - NTP Study Findings and Cancer. Explication by Dr. Ronald Melnick of NIH NTP study results and the demonstration by that study of cell phone cancer link. As stated by Dr. Melnick, in addition to brain gliomas and heart schwannomas, the NTP study found evidence of cardiomyopathy, pre-cancerous lesions, reduction in birth weight, and exposure-related increases in DNA damage in the brains of test animals. Evidence of DNA strand breaks was determined by means of comet assay.

The 2011 IARC classification of radiofrequency radiation as a Group 2B possible human carcinogen was based largely upon the epidemiologic findings of the Swedish (Hardell, et al.) and Interphone case-control human studies, both of which found significantly increased risk in glioma and acoustic neuroma (vestibular schwannoma) to be associated with extended periods of cell phone use.

Another human epidemiologic, case-control study, the 'Cerenat, France' study, found a 5-fold increased risk of glioma after 5+ years of cell phone use.

The results of the NTP animal studies, particularly the cancers in the heart (schwannomas) and cancers in the brain (gliomas), strongly corroborate the epidemiologic findings of the Swedish, Interphone and Cerenat human studies.

According to Dr. Melnick, the NTP study was designed specifically to test the 'null hypothesis' of 'no effect'. The key findings of the NTP study definitively have answered the question of whether or not the null hypothesis is correct. In the words of Dr. Melnick (at 8:24 and 9:27 minute-marks):

"The assumption now that non-ionizing radiation cannot cause cancer or other health effects other than tissue heating is definitely wrong." (Underlining and emphasis added.)

EXHIBIT 24B-2 (FD):
Dr. Ronald Melnick delivers NTP cell phone cancer study presentation prepared by Dr. Linda Birnbaum, Director of the National Institute of Environmental Health Sciences (NIEHS).

EXHIBIT 24C-1 (FD):
Risks: Adverse Health Impacts - Cancer Classifications by Government Standards. Dr. Anthony B. Miller, MD, FRCP, Professor Emeritus, Dalla Lana School of Public Health and Chair, Department of Preventive Medicine and Biostatistics, University of Toronto; Director of Epidemiology Unit, National Cancer Institute of Canada; Senior Epidemiologist, International Agency for Research on Cancer (IARC); Former Advisor to the World Health Organization (WHO); Consultant to Division of Cancer Prevention, U.S. National Cancer Institute; Head, Division of Cancer Epidemiology, German Cancer Research Centre.

Dr. Miller presents details on the body of evidence derived from human (epidemiologic) studies linking wireless and cell phone radiofrequency radiation to cancer. Near the close of his presentation (at 9:23), Dr. Miller states:

"My conclusion is, as a result of the evidence I've shown you, that if the International Agency were to re-convene a working group to re-evaluate radiofrequency radiation, they would be bound to conclude—with the human evidence we've got, the animal evidence that Dr. Melnick has talked about, and the mechanistic evidence that Dr. Heroux will tell us shortly—that this exposure is a human carcinogen." (Underlining and emphasis added.)

EXHIBIT 24C-2 (FD):
Concerning justification for re-classification of radiofrequency radiation, Dr. Anthony Miller, MD, further states:

"But when you add the animal study from the National Toxicology Program, the combined evidence, in my view, is that there is now sufficient evidence that radiofrequency radiation is carcinogenic to humans. That's IARC Category 1, and you can't ignore that." (Underlining and emphasis added.)

EXHIBIT 24C-3 (FD):
Additional commentary by Dr. Anthony Miller, MD, that in his opinion, "it is very clear" that electro-hypersensitivity "is a syndrome that exists."

EXHIBIT 24D-1 (FD):
Risks: Adverse Health Impacts - Mechanisms and Biological Cell Functions. Dr. Paul Heroux, PhD, Physicist, Medical Scientist, Professor of Toxicology and Program Director, Department of Epidemiology and Occupational Health, McGill University of Medicine, Montreal, Canada.

Dr. Heroux illustrates aspects of mechanisms such as reactive oxygen species (ROS) by which radiofrequency radiation is capable of inducing adverse health effects including cancer. He states that his research results show that radiofrequency fields are more disruptive to cells than oxygen.

EXHIBIT 24D-2 (FD):
Dr. Paul Heroux addresses NIH/NIEHS/NTP peer-review panel of scientists concerning mechanisms of effects of radiofrequency radiation upon biological systems. Beginning at 5:09 minute-mark, Dr. Heroux states:

"Although some have claimed that exposures used in the NTP are high in comparison with human exposures, this criticism ignores the fact that in the study, two years of rodent life are meant to represent the full human life span. If anything, this study **underestimates** the effects, and I would expect **more cancers** as well as other health problems ... to manifest later on, should one use rodents with seventy-year longevity."

EXHIBIT 24D-3 (FD):
Dr. Paul Heroux states that he has "conducted detailed experiments that prove, without a doubt, that electromagnetic radiation, even at low levels, has decisive, significant impact on biological systems. And to ignore these effects is extremely, extremely negligent."

EXHIBIT 24E (FD):
The Public Has a Right to Know about the Health Risks of Wireless. James S. Turner, Esq., President of the National Institute for Science, Law and Public Policy. Mr. Turner states in part:

"Issue after issue, when the science battle has been won on our side, they [industry] go to the courts. They go to the law. They try to cut off the information. **The fact is that the scientific basis of this case has been made.** More will be added, it will be fleshed out, but in fact, the science is clear. The simple issue is: are all of the harms

from EMF only from thermal causes, or do they come from additional causes as well. **It is absolutely, unequivocally clear that the danger is not limited to thermal. That issue has been won.** They are now in the courts. They are now blocking getting that information out to the public. That is progress. Now, the issue is: do the PR, do the progress reports to fight in the courts. The issue here now is: get the information to the public. You heard it all. There is more to be found, there's more to be done, but there is enough information that when the public hears about this, they will get engaged as they have on many other issues. ... There are issue after issue like this, and they all begin and develop ... like a plant ... by seedlings at the local communities and then they develop and grow into a tree that dominates what is accepted as the public knowledge. The number one thing that needs to be done right now is to make sure that local access to fighting these issues—the EMF issues—is not cut off by legislation." (Underlining and emphasis added.)

EXHIBIT 24F (FD):
Comments about the NTP Cell Phone Radiation Studies. Dr. Joel M. Moskowitz, Ph.D., School of Public Health, University of California, Berkeley. Reads in part:

"[A] 5-year, $5 million Air Force study found low incidences of many types of tumors in male rats exposed to microwave radiation (Chou et al, 1992). **In that study, the exposed rats were three times more likely to get cancer than the control rats**. **The study employed much lower intensity microwave radiation than the NTP studies**." (Underlining and emphasis added.)

...

"In addition to the NTP studies of cell phone radiation (NTP, 2016; NTP 2018a; NTP 2018b), three studies have reported increased cancer risk in animal models from long-term exposure to lower intensity microwave radiation than employed in the NTP studies (see references below for study abstracts: Chou et al., 1992; Repacholi et al., 1997; Falcioni et al., 2018).

"Newly-published results by the **Ramazzini Institute** from the largest study on the health effects of cell phone radiation in rats **replicate the brain and heart tumor results from the NTP rat study** (Falcioni et al., 2018). Yet, **the Institute used** a different GSM carrier frequency (1800 MHz vs. 900 MHz) and **much lower intensity microwave radiation exposures than the NTP study**. The Specific Absorption Rates ranged from 0.001 -0.1 W/kg SAR in this study as compared to 1.5 -6.0 W/kg in the NTP study. These results suggest that the cancer effects observed in the male rats of the NTP study are robust. (Emphasis added.)

"**The NTP and the other animal studies are the missing links. These studies prove that long-term exposure to low intensity, non-thermal levels of microwave radiation can cause DNA damage and cancer in an animal model.** To date, many hundreds of studies have found increased oxidative stress

(including stress proteins, free radicals and DNA damage) from exposure to low intensity microwave radiation. (Underlining added.)

"Since the 2011 IARC review, additional human studies have been published which find an association between long-term, heavy cell phone use and risk of glioma (Coureau et al., 2014; Grell et al., 2016; Hardell et al., 2013a, 2013b; Momoli et al., 2017; Turner et al, 2016) or vestibular schwannoma (also known as acoustic neuroma) (Benson et al., 2013; Hardell et al., 2013c; Moon et al, 2014).

"Due to the new animal and human evidence of carcinogenicity since 2011, many EMF scientists are now calling for re-classification of radio frequency radiation either to "probably carcinogenic to humans" (Group 2A) or "carcinogenic to humans" (Group 1) (e.g., Morgan et al., 2015; Carlberg and Hardell, 2017)."

EXHIBIT 24G (FD):
"SPIN vs FACT: ***National Toxicology Program*** report on cancer risk from cellphone radiation." The following tabularized information was compiled by Dr. Joel M. Moskowitz, PhD, Director, Center for Family and Community Health, University of California, Berkeley.

"The National Toxicology Program (NTP) of the National Institutes of Health reported partial findings from their $25 million study of the cancer risk from cellphone radiofrequency radiation (RFR). Controlled studies of rats showed that RFR caused two types of tumors, glioma and schwannoma. The results '…could have broad implications for public health.' Below are some biased statements, or 'Spin,' about the study that tend to create doubt about data quality and implications, as well as 'Facts' from decades of previous research."

SPIN	FACT
Conclusions are faulty. Dr. Michael Lauer, deputy director for extramural research at the National Institutes of Health, "I am unable to accept the authors' conclusions."	The NTP is world-renowned for toxicology research. This is "by far … the most carefully done cell phone" toxicology study of RFR carcinogenic effects. Criticisms by Dr. Lauer and other scientists who reviewed the study were **rebutted in the study report**.
Study reports a "low incidence" of tumors in the brain and heart in rats exposed to RFR.	The study found that **one in twelve (8.5%)** of the 540 male rats exposed to cellphone radiation developed **cancer or pre-cancerous cells** as compared to none of the 90 rats in the control condition.
Relevance of animal studies to humans is questionable.	The cells that developed tumors are the **same cells** that display elevated tumor risk in studies of long-term, heavy **cellphone users**. Rats are the preferred animal model for carcinogenicity studies.

International Agency for Research on Cancer (IARC), rated cellphone radiation a "possible'' human carcinogen (Group 2B), the same rating given to coffee, pickled vegetables, and talc.	The report provides strong evidence that RFR exposure causes cancer. Major studies published since the 2011 IARC meeting consistently find that long-term, heavy cellphone users have increased risk of brain tumors. Group **2B carcinogens also include DDT, lead, and diesel fumes.**
Prior research contradicts NTP study results (e.g., Danish Cohort Study, British Million Women Study).	The Danish study has been criticized by many scientists for excluding heavy cellphone users. The British Study has also been criticized; but, it found **evidence for acoustic neuroma** (a form of schwannoma).
Epidemiological studies fail to show an increase in brain tumor incidence since 1992 even though cellphone use has mushroomed.	The incidence of nonmalignant tumors has significantly increased in the U.S. since cellphones. Moreover, the incidence of glioblastoma multiforme, the most serious type of brain cancer, has increased in **parts of the brain proximal to where cellphones are held**. Brain cancer can take decades to develop, so it is premature to see overall increases in malignant tumors in the general population.
There is no mechanism to explain how cellphones could cause cancer. Unlike ionizing radiation, *non-ionizing* radiation from cellphones cannot damage DNA.	A review paper reported that in 93 of 100 studies **RFR produced a cellular stress response** which can lead to DNA damage and cancer. The NTP study also found evidence of DNA damage. Several published papers present evidence for different mechanisms by which RFR may cause cancer.
The research has not been peer-reviewed.	The NTP report has been peer-reviewed by experts. Some **reviews appear in the report** along with the authors' responses.
Findings are preliminary, it is premature to conclude we should take precautions or change policy.	These are not preliminary findings. According to NTP, the effects of RFR on these two tumors, glioma and schwannoma, are final. The federal government released this partial report because the results "could have broad implications" **for the public due to widespread cellphone use**. The NTP posted on its website a link to the FDA's recommendations on how to reduce cellphone radiation exposure.

(Note: The preceding table does not indicate that in the NTP study, the RF radiation dosage received by the animals over their expected two-year life-spans was intended to simulate or model the RFR dosage that a person would receive from regular use of a cell phone over a lifetime of seventy years. The fact that the NTP study found clear evidence of cancer causation as well as pre-cancerous lesions and DNA damage in the animals from exposure to RF radiation is strongly indicative that the lifetime risk to humans of DNA damage and cancer from exposure to RF radiation is not negligible.)

EXHIBIT 24H (FD):
Cell Phones & Brain Cancer - What the Research Shows. Expert Roundtable presentation given by Dr. Joel Moskowitz, PhD.

EXHIBIT 24J (FD):
ACS Responds to New Study Linking Cell Phone Radiation to Cancer. Commentary by Otis W. Brawley, MD, American Cancer Society Chief Medical Officer, on the NTP RF study. Reads in part:

"The new report covers only partial findings from the study, but importantly one of the two cancers linked to cell phone radiation was malignant gliomas in the brain. **The association with gliomas and acoustic neuromas had been suspected from human epidemiology studies**. The second cancer, called a schwannoma, is an extremely rare tumor in humans and animals, **reducing the possibility that this is a chance finding**. (Underlining and emphasis added.)
...
"The NTP was given the difficult task of trying to answer important questions about the potential cancer risk posed by cell phones, and the group did not shirk from its responsibility. NTP staff were clearly aware of the potential importance of this study and went the extra distance to ensure the best science is used.
...
"NTP staff were clearly aware of the potential importance of this study and **went the extra distance to ensure the best science is used**. They used double the number of animals required for this type of study; they convened not one but three panels to look at abnormal tissues from treated animals to ensure that what was identified as a brain and heart tumor was indeed a brain and heart tumor; they solicited review from multiple scientists from outside the NTP to critically review all aspects of the data analysis and study findings, to ensure the findings would stand up to the critical assessment expected once these unexpected findings were released."

Genotoxic and carcinogenic effects of non-ionizing electromagnetic fields. A. Kocaman, G. Altun, A. Kaplan, O. Deniz, K. Yurt, S. Kaplan. Environmental Research 163 (**2018**) 71-79. (**EXHIBIT 44G.**) Reads in part:

"There is some confusion about the fact that the **[NTP] report** was issued as a partial report in 2016. The leaders of that program have explained that the report was issued as a partial report because they were quite concerned and surprised at these findings ***especially in the light of the human results showing similar increased cancers***." (Underlining, italics and emphasis added.)

EXHIBIT 26 (FD):
Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). Miller, A.B., Morgan,

L.L., Udasin, I., Davis, D.L. (Environmental Research 167 (**2018**) 673-683.) Reads in part:

"When considered with recent animal experiments, ***the recent epidemiological studies strengthen and support the conclusion that RFR should be categorized as*** **carcinogenic to humans (IARC Group 1)**."

...

"**The Epidemiological studies reported since the 2011 IARC Working Group meeting are adequate to consider RFR as a probable human carcinogen (Group 2 A)**. However, they must be supplemented with **the recently reported animal data as performed at the Ramazzini Institute and the US National Toxicology Program as well as by mechanistic studies**. **These experimental findings together with the epidemiology reviewed here are sufficient in our opinion, to upgrade the IARC categorization of RFR to Group 1, carcinogenic to humans**."

...

"In light of the evolving science concerning mobile phone and screen time exposures and the longer-term risk of cancer established by both epidemiological and toxicological studies, current evidence is strong enough to go from precaution concerning possible risk to prevention of known risks."

...

"Epidemiological studies necessarily confirm the impact of past exposures, while experimental studies provide indications of future risk. Thus, experimental evaluations and modeling are essential before distributing newer systems ... for which no safety data have been obtained. The absence of systematic testing of such technologies should not be confused with proof of safety." (Underlining, italics and emphasis added.)

In addition to evidence from mechanistic studies, the peer-reviewed ***final*** report of the U.S. National Toxicology Program (**NTP**) has concluded there is "**clear evidence**" that exposure to cell phone radiofrequency radiation can cause and/or increase the risk cancer. (**EXHIBITS 23, 24A, 25, 26**, etc.) At least one study showed adverse cellular effects from exposure to a 960 MHz GSM cell phone signal at a specific absorption rate that was *more than 100,000 times* ***less*** than the ICNIRP/WHO safety guidelines. (**EXHIBIT 44J**.)

EXHIBIT 27 (FD):

Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective Dominique Belpomme, Lennart Hardell, Igor Belyaev, Ernesto Burgio, David O. Carpenter. Environmental Pollution 242 (2018) 643-658. https://ecfsapi.fcc.gov/file/12103008105187/nonionizing%20radiation%20international%20perspective%20Belpomme%20Hardell%20Carpenter%202018.pdf

Reads in part:

"Exposure to low frequency and radiofrequency electromagnetic fields at low intensities poses a significant health hazard that has not been adequately addressed by national and international organizations such as the **World Health Organization**. ***There is strong evidence that excessive exposure to mobilephone-frequencies over long periods of time increases the risk of brain cancer both in humans and animals***. The mechanism(s) responsible include induction of reactive oxygen species, gene expression alteration and DNA damage through both epigenetic and genetic processes. In vivo and in vitro studies demonstrate adverse effects on male and female reproduction, almost certainly due to generation of reactive oxygen species. ... ***There is increasing evidence the exposures can result in neurobehavioral decrements*** and that some individuals develop a syndrome of "***electro-hypersensitivity***" or "microwave illness", which is one of several syndromes commonly categorized as "***idiopathic environmental intolerance***". While the symptoms are non-specific, new biochemical indicators and imaging techniques allow diagnosis that ***excludes the symptoms as being only psychosomatic***. Unfortunately standards set by most national and international bodies are not protective of human health. ... The endogenous natural ionic currents and electrical fields in the human body (Jaffe and Nuccitelli, 1977) are vulnerable to the oscillary properties of non-thermal EMFs. ... There has long been evidence that EMFs alter several aspects of calcium function. This is important because calcium regulates many different aspects of cell function. ... Safety limits for RF exposure have been based (until today) on the thermal effects of EMFs. **But these standards do not protect people, particularly children**, from the deleterious health effects of non-thermal EMFs. ... **The scientific evidence for harm from EMFs is increasingly strong**." (Underlining, italics and emphasis added.)

The content of **EXHIBIT 29A** corrects for calculations in the California Council of Science and Technology report that were made on the basis of a flawed comparative analysis. More specifically, **instead of using whole-body RF dosage levels from the cell phone model, the CCST used cell phone dosages only to the ear and compared these with whole-body RF dosages from smart meters. Secondly, the CCST assumed a 100% duty cycle for smart meters and only a 1% duty cycle for cell phones. However, the CCST did not correct for this. Moreover, the CCST report does not consider cumulative exposure.**

EXHIBIT 29A (FD):
Comments on the Draft Report by the California Council of Science and Technology "Health Impacts of Radio Frequency from Smart Meters". Daniel Hirsch, PhD, Director and Senior Lecturer of the Program on Environmental and

Nuclear Policy, University of California, Santa Cruz. Dr. Hirsch's analysis consists of an examination of the computational flaws in the CCST Draft Report as pertain to its comparison of levels of cell phone and smart meter radiation exposure.

In his commentary, Dr. Hirsch asserts: "CCST did not correct numerous other apparent errors from the EPRI brochure when it adopted EPRI's values. For example, for cell phone exposures, CCST did not correct for the presumed duty cycle of the cell phone (which CCST indicates on average is 1%). Nor did it convert the EPRI cell phone power density estimate into comparable units. EPRI (and thus CCST) compared a *whole body average* exposure to SmartMeter radiation to *peak exposure to the ear* for the cell phone. One needs to compare apples and apples, or whole body exposures to whole body exposures. Comparing the peak dose to the ear from a cell phone, when the rest of the body gets vastly less radiation, with a whole body exposure where all organs get roughly the same dose from a SmartMeter, doesn't seem appropriate."

Correcting for these flaws and comparing cell phone and smart meter RF radiation in terms of ***cumulative, whole-body exposure***, Dr. Hirsch has calculated that: "Averaging over the full potentially exposed surface area of the body (presuming only half the body surface could be exposed to the cell phone from any one angle), the whole body exposure would be approximately on average 0.25 mW/cm^2 given the maximum value to the ear of 5 mW/cm^2 put forward by EPRI and the CCST draft report and correcting as well for the duty cycle. **The SmartMeter thus would produce 160 times more cumulative whole body exposure than the cell phone assuming this estimate for whole body exposure.**" Using an alternative model, Dr. Hirsch's recalculation "**suggests the SmartMeter would produce 50 times the cumulative whole body exposure as a cell phone.**" At a distance of 10 feet from a smart meter, and also taking into account total time of exposure per 24-hour duty cycle, a person would receive 5 to 16 times the whole-body radiation exposure than would be received from a cell phone held to the head. (Underlining and emphasis added.)

EXHIBIT 29B (FD):
Commentary by Dr. Daniel Hirsch, PhD, on his corrective recalculation of levels of RF radiation exposure from wireless smart meters as compared to cell phones. Dr. Hirsch briefly explains the CCST's flawed analysis and calculations made on the basis of an 'apples-to-oranges' comparison in its assessment of relative exposure levels of RF from smart meters and cell phones. ***Based upon his analysis and calculations, the cumulative, whole-body exposure from a smart meter at a distance of 3 feet is between 50 and 160, or roughly 100 times that from typical use of a cell phone***.

EXHIBIT 29C-1 (FD):
Commentary on the California Council on Science and Technology Report "Health Impacts of Radio Frequency from Smart Meters", Dr. Karl Maret, MD, BS, Electrical Engineering, Master of Engineering in Biomedical Engineering, 4-year Postdoctoral Fellow in Physiology. Dr. Maret has had a dedicated interest in the health effects of electromagnetic fields (EMFs) for many years and has given lectures in Europe and the United States on impacts of non-ionizing radiation. Dr. Maret's commentary reads in part:

"I submit that the CCST report, written in response to health concerns expressed by Assembly Members of the California Legislature, contains inaccuracies and minimizes the biological effects and health impacts of non-thermal radiofrequency radiation, such as those produced by wireless technologies including Smart Meters."
...
"My specific concerns with the report are as follows:

1. The minimization of the problem of non-thermal microwave radiation;
2. The minimization of the need for lower exposure standards;
3. The increase in radiation levels at potential local hotspots through reflection;
4. The lack of information about the impact of pulsed radiation from Smart Meters;
5. The lack of information on the health impacts of night-time radiation from Smart Meters;
6. The lack of modeling or actual measurements of the contribution from Smart Meters to the existing background microwave radiation;"
...

1. Minimization of Non-thermal Microwave Radiation from Smart Meters

"On page 4 of the CCST report it states that *'To date, scientific studies have not identified or confirmed negative health effects from potential non-thermal impacts of RF emissions such as those produced by existing household electronic devices or smart meters.'* This finding minimizes the extensive body of scientific research on the biological effects of non-thermal electromagnetic fields. The biological effects of low-level, non-thermal electromagnetic fields have been researched for over 30 years. The respected 2007 Handbook of Biological Effects of Electromagnetic Fields edited by Barnes and Greenebaum (1) states on page 377:

'The biophysical lore prevailing until the late 1980s and lingering to this day is that, unless the amplitude and frequencies of an applied electric field were sufficient to trigger an excitable membrane (e.g. heart pacemaker), produce tissue heating or move an ion along a field gradient,

there could be no effect. .... However, this position had to be changed as the evidence for weak (non-thermal) EMF bioeffects became overwhelming.'

Prof. Arthur Pilla, PhD
Professor of Biomedical Engineering, Columbia University

"There are numerous reports on the potential health effects of non-thermal electromagnetic fields. Early reports include papers by Frey (1993), Lai (2000) and Hyland (2000), among many others. An international working group has delineated many additional scientific findings (Bioinitiative report, 2007). Special editions of the journal Pathophysiology were specifically dedicated to this topic recently (Pathophysiology, 2009). Recently, the European Journal of Oncology published an entire monograph entitled "Non-Thermal Effects and Mechanisms of Interaction between Electromagnetic Fields and Living Matter" outlining nonthermal effects on living systems. This came from the National Institute for the Study and Control of Cancer and Environmental Diseases "Bernardino Ramazzini" (Giuliani & Soffriti, 2010).

"The CCST report further states that, *'Without a clearer understanding of the biological mechanisms involved, identifying additional standards or evaluating the relative costs and benefits of those standards cannot be determined at this time.'* I strongly disagree with this conclusion as there is now a large body of scientific literature describing several key mechanisms for the action of weak electromagnetic fields. These include, among others:

- removal of calcium ions bound to cellular membranes, leading to their weakened structure and changed cellular functioning
- change of calcium ion leading to changes in metabolic processes in cells,
- the leakage of calcium ions into neurons generating spurious action potentials,
- fragmentation of DNA in cells seen through the Comet assay
- changes in the blood-brain barrier in animals after microwave exposure
- defined cellular stress response, including the production of heat shock proteins (HSP), that are triggered electromagnetically at non-thermal levels that require much less energy than when triggered by heat (so-called thermal considerations)
- activation of specific genes by exposure to non-thermal electromagnetic fields leading to gene transcription to form RNA, the first stage in the synthesis of proteins

"All these biological effects are well substantiated in the scientific literature and occurred at much lower exposure levels than current FCC standards, but are minimized by the CCST report. It takes many years for definitive health effects to be substantiated beyond all shadow of doubt. Yet the evidence is accumulating that

health effects will become more widespread, given sufficient time, from the scientifically researched biological responses to RFR. Until the authors of the CCST report can clearly substantiate their conclusions that the California population will not be adversely affected by the Smart Meter program, a precautionary approach should have been recommended."

...

"Biological systems often respond in a non-linear manner and there is a large degree of genetic variability as to how animals or people are affected. Non-thermal EMFs might be comparable to the hazards of low levels of toxins found in the environment which can be potent in very low levels at disrupting enzyme systems in the body, but may not be proportionately worse at higher levels.

"Dr. Richard Gautier in France offered a full description of active mechanisms for the action of non-thermal EMFs. There are peer-reviewed scientific studies for each step of the processes that can lead to chronic diseases such as cancer, leukemia and neurological diseases. These conditions often require longer time periods to develop and the Precautionary Principle (see later) ought to be applied when adding new sources of microwave radiation such as those from Smart Meters that are active night and day in our
homes and places of work.

"On page 14 of the CCST report, the statement *'There is currently no definitive evidence linking cell phone usage with increased incidence of cancer'* is another misleading statement that tends to minimize the cancer risk from cell phones. If the authors of the CCST report had looked at other papers from the scientific literature (not mentioned in pages 38-44 of the CCST report), they might come to different conclusions.

"There is mounting evidence of various types of tumors being caused from cell phone usage including parotid gland tumor (Czerninski, 2011), meningioma (Hardell et al., 2006), acoustic neuroma (Sato et al. 2011), brain tumors (Hardell & Carlberg, 2009) and testicular tumors (Hardell et al., 2007), to name only some. Considering the increasing number of scientific papers describing various types of tumors associated with non-thermal radiation from cell phones that are appearing in the medical literature, it is not helpful that non-thermal radiations from Smart Meters, which might potentially add to our long-term susceptibility to serious diseases, be minimized as was done in the report."

2. The minimization of the need for lower exposure standards

"The report states on page 8 that *'...given the existing uncertainty about non-thermal effects, there is no generally accepted, definitive, evidence-based indication that additional standards are needed.'* This statement is misleading since

an international collaboration of researchers in this field have called for a reexamination of the current ANSI standard based on the increasing evidence of the adverse effects of low-level electromagnetic fields (Hardell and Sage, 2008) Various research groups have consistently warned that the existing guidelines may be inadequate (Hyland, 2000; Levitt &Lai 2010; Bioinitiative Report, 2007).

"Even the International Commission on Non-Ionizing Radiation Protection (ICNIRP) stated in 1998 that 'interpretation of several observed biological effects of electromagnetic fields is further complicated by the apparent existence of "windows" of response in both the power density and frequency domains. There are no accepted models that adequately explain these phenomena, which challenge the traditional concept of a monotonic relationship between the field intensity and the severity of the resulting biological effects.' (ICNIRP, 1998). In other words, there are windows of sensitive biological response in which potential health effects can occur at much lower exposure levels than currently mandated by the FCC standards.

"Already in 1999, the federal government's Radiofrequency Interagency Work Group (RFIAWG) had 'identified certain issues that we believe need to be addressed to provide a strong and credible rationale to support RF exposure guidelines.' Dr. Gregory Lotz from the Department of Health and Human Services, National Institute for Occupational Safety and Health addressed these specific issues in a letter dated June 17, 1999 to Mr. Richard Tell, then Chair of the IEE SCC28 (SC4) Risk Assessment Work Group. Ironically, it was this same Richard Tell Associates of Las Vegas, NV who wrote the report for PG&E describing the apparent safe exposure limits of the Smart Meter program that was also referenced in the
CCST report (Tell, 2005; Tell, 2008).

"The Tell Associates report simplified the apparent safety of the Smart Meter radiation by:

1. Only considering a single isolated Smart Meter radiator in free space;
2. Time averaging the pulse RF radiation so that it appeared as a low level of 8.8 uW/cm^2;
3. Not considering other RF microwave emitters in the home environment; and
4. Considering only ground wave reflections of the microwave emissions and no other reflective surfaces (see below).

The report also does not address the concerns of the federal RF Interagency Work Group including among other concerns:

1. The biological basis for local SAR limit;

2. the selection of an adverse effect level;
3. the nature of acute versus chronic exposure;
4. the intensity or pulsed or frequency modulated RF exposure; and
5. the issue of time averaging.

"These are critical issues which make the issue of proper exposure guidelines a central issue in this matter. It further casts great doubt on the conclusions of the CCST report that downplays the need for new, lower exposure standards."

"Epidemiologic evidence is a major contributor to the understanding of the potential effects of EMF on health. The International Agency for Research on Cancer (IARC) classified EMF as a 'possible human carcinogen', or a Group 2B carcinogen; (IARC, 2002) this classification was mostly based on consistent epidemiological evidence. Although the body of evidence is always considered as a whole, based on the weight of evidence approach and incorporating different lines of scientific enquiry, epidemiologic evidence, as most relevant, is given the greatest weight.

"Several European countries, having taken a deeper look at recent scientific data, are beginning to follow a different approach to the RFR question. They recommend prudent avoidance in siting cell tower antenna installations near schools, hospitals or wherever people congregate. This approach is part of what is called the Precautionary Principle, which has been adopted in many countries, including the U.S., for various applications in international treaties. The Precautionary Principle holds that when questions of safety are concerned, precautions should be taken to protect public health even if scientific data is incomplete, or the mechanisms of action are not understood (Levitt, 2000; Kheifets et al., 2001)."

...

4. The lack of information about the impact of pulsed radiation from Smart Meters

"There is considerable difference between the biological impact of pulsed microwaves, as produced by Smart Meters, compared to continuous waves, such as those produced by microwave ovens. No distinction is made in the safety criteria between continuous and pulsed waves because of the narrow-minded focus on thermal damage alone. Many scientific studies have pointed out that radiofrequency radiation with different modulations and pulse characteristics produce different biological effects even though they may produce the same pattern of different specific absorption rate distribution and tissue heating (Levitt &Lai, 2010).

"Peer-reviewed studies have shown that the differences in modulation patterns and waveforms can produce quite different biological effects. They include the works of Arber and Lin (1985); Campisi et al (2010); Huber et al. (2002); Luukkonen et

al. (2009); d'Ambrosio et al (2002), among many others. Already Soviet research in the 1960s showed that pulsed waves induced stronger and often inhibitory biological and neurological effects than continuous waves (Osipov, 1965). A review of the hazards to U.S. military personnel from high frequency electromagnetic radiation was provided by Pollack (1967) which gives an overview of the extensive Eastern European research in this field.

"Marha (1963) described allowable intensities for frequencies above 300 MHz in Czechoslovakia for continuous waves as 25 uW/cm^2 but limited pulsed waves to only 10 uW/cm^2. Note that these Czech recommended levels were considerably lower than the approximately 600 uW/cm^2 allowed for the RFR from Smart Meters operating in the low 900 MHz band mandated by the FCC based on only thermal consideration. Also not well known in the West is the Soviet work showing the adverse effect of non-thermal pulsed microwave radiation on cardiac rhythms in animals (Presman & Levitina, 1962).

"The CCST report is misleading because it compares the Smart Meter emissions to those of microwave ovens. Microwave ovens produce much higher power output but are not modulated or pulsed in any way. **It is imperative to understand that it is the modulation or pulsation pattern that leads to biological effects at non-thermal power levels**. Biologically sensitive amplitude windows have been found at specific frequencies that lead to the selective release of calcium from cell membranes. However, above and below these unique power densities there is no observable effect. **Pulses and square waves have the greatest biological impact because they produce rapid changes in voltage across biological membranes**. Un-modulated carrier waves have little or no biological effect except if their power is sufficiently high, such as in microwave ovens. Comparing the power levels between modulated and un-modulated devices, as the CCST report does, is thus misleading." (Emphasis added.)

EXHIBIT 29C-2 (FD):
California Department of Public Health (CDPH) technical comments on the CCST report, *Health Impacts of Radio Frequency from Smart Meters*. https://ccst.us/projects/smart2/documents/letter3.pdf

Reads in part:

"**The reassurance that Smart Meters emit radio frequency emfs well below cell phones (see figure 1; page 5 of the report) and therefore should be considered safe, appears to be based upon an incorrect representation of cell phone emf strength that was calculated; not measured**. Cell phones emit much lower emfs that are closer to those of the Smart Meters. Our measurements of emissions from

many cell phones (directly next to the device) under a variety of weak and strong signal conditions all fall under 80 micro watts per square centimeter; often much lower. **Frequently, these cell phone emissions are lower than the 40 micro watts per square centimeter shown for the smart meter at 3 feet**.

"The representation of Smart Meter emissions is based upon controlled conditions and not real world conditions. **The same figure 1 on page 5 shows minimum and maximum values for a Smart Meter at 3 and 10 feet are the same; suggesting no variability. Our in-the-field measurements show appreciable variability**. Also, it is not clear why 3 and 10 feet were chosen for the comparison. **It would be useful to determine the percentage of people spending time closer than three feet to the meter and the percentage of their time within that radius**.

"The report states on page 4, point 3 under Other Considerations, "The California Public Utilities Commission should consider doing an independent review of the deployment of smart meters to determine if they are installed and operating consistent with the information provided to the consumer." **This is an important finding, and raises doubt about the strong reassurances provided in Key Findings in the absence of independent review of installed meters in the field**.

"**CDPH** suggests further review of the literature on non-thermal effects ... but **does not support a claim of no non-thermal health effects from radio frequency electromagnetic fields**."

(Underlining and emphasis added.)

EXHIBIT 29C-3 (FD):
EMF Safety Network Opening Brief before the Public Utilities Commission of the State of California. Pages 12-13 read in part:

"PG&E has acknowledged that the maximum permissible exposure (MPE) for radiation at its Smart Meter operating frequency of 900 MHz among the general population is 600 microwatts per square centimeter.[36] But the standard is incomplete without mentioning averaging time, which for general population exposures at 900 MHz is 30 minutes. This can be expressed as 600 microwatts times 30 minutes, or 18,000 microwatt-minutes per square centimeter.

"Exposure of an hour (60 minutes) would mean that power density must decline to 300 microwatts over that period in order for the MPE limit to be maintained. (300 microwatts times 60 minutes = 18,000 microwatt-minutes). For eight hours, the power density, on average, must drop to 300 divided by 8, or 37.5 microwatts per square centimeter.[37]

"General population exposures of eight hours to Smart Meter radiation is not a far-fetched scenario. Imagine, for example, a bed with its headboard against same wall, internally, as the Smart Meter is affixed to externally. If the bed were occupied by an ill resident, the exposure could extend well beyond the eight hours of night sleep.

"Table 1 and Table 2 answer the questions, "What power densities might a person be exposed to by a Smart Meter and how does that exposure compare to a time-adjusted limit?"[38] The first table is "worst case" in that "Max EIRP" shows the highest power possible and "Max Environment" postulates continuous use. The second table adjusts for time of exposure relative to the 30 minutes in the FCC limit. Thus, Smart Meter 1 is adjusted from 600 to 6000 microwatts per square centimeter because reading it is assigned three minutes, only one-tenth of the 30 minutes in the FCC limit. On the other hand, Smart Meter 2 – positing a nearby human sleeper – is adjusted to 37.5 microwatts per square centimeter based on the eight hours discussed above.

Table 1

Device	Use Case	Frequency (MHz)	FCC Limit (µW/cm2)	Max EIRP (µW)	Typical User Distance (cm)	Max Environment [continuous Tx] (µW/cm2)	% of Limit
smart meter 1	daily reading	902-928	600	2500000	20	497.359301	82.9%
smart meter 2	sleeping opposite meter	902-928	600	2500000	30	221.048578	36.8%

Table 2

Device	Use Case	User Residence Time (hours per day)	Adjusted Limit (µW/cm^2)	Adj. Power Density [continuous Tx] (µW/cm^2)	% of Adjusted Limit
smart meter 1	daily reading	0.05	6000.0	1.036165	0.0%
smart meter 2	sleeping opposite meter	8	37.5	73.682859	196.5%

"It should quickly be noted that the tables do not account for reflected augmentation of radiation or for other than free-space losses, such as would be attributable to meter housings, exterior walls, etc. Nor do they factor in duty cycles. In the case of reflections and losses, these indices vary widely by environment. In the matter of duty cycles, omitting these creates a worse-than-usual case which Network believes

essential to the practice of prudent avoidance of potential radiation harms.

"It is sobering to recognize that Smart Meter 2 in the second table comes in at nearly 200 per cent of the adjusted FCC limit of 37.5 microwatts per square centimeter for the eight-hour period. If this is true for a general population in which adverse medical conditions are not presumed, there should be an even greater concern for protecting those who suffer from RF radiation-related disabilities or medical conditions. Under no circumstances should such persons be forced to pay a financial penalty for practicing prudent avoidance of Smart Meters." (Underlining added.)

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[36] Declaration of Daniel Partridge, ¶ 7, appended to PG&E Motion for Immediate Dismissal, filed May 17,2010, A10-04-018. The MPE is derived from safeguards on non-ionizing radiation promulgated by the Federal Communications Commission (FCC) at 47 CFR § 1.1310

[37] OET Bulletin 65, page 11, equation 2, http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf

[38] The tables are the work of Mitch Maifeld, a professional engineer registered in the State of Ohio, www.zenzic.biz

EXHIBIT 29C-4 (FD):

County of Santa Cruz proposed ordinance with attached memorandum entitled ***Health Risks Associated with SmartMeters***. These documents point to the inadequacies of the CCST report and read in part:

[Santa Cruz - Begin quote]

FCC safety standards do not exist for chronic long-term exposure to EMF or from multiple sources ... . Because of untested technology, international scientists, environmental agencies, advocacy groups and doctors are calling for the use of caution in wireless technologies;

...

The public health issue of concern in regard to SmartMeters is the involuntary exposure of individuals and households to electromagnetic field (EMF) radiation.

...

The Federal Communications Commission (FCC) has adopted limits for Maximum Permissible Exposure (MPE) that are based on exposure guidelines ... expressed in units of microwatts per centimeter squared. A SmartMeter contains two antennas whose combined time-averaged public safety limit of exposure is 655 $\mu W/cm^2$ (Sage, 2011). According to the California Council on Science and Technology (CCST) Report (2011), within distances of three to ten feet, SmartMeters would not exceed this limit. However, **CCST did not account for the frequency of transmissions, reflection factors, banks of SmartMeters firing simultaneously, and distances closer than three feet**. **There are numerous situations in which**

the distance between the SmartMeters and humans is less than three feet on an ongoing basis, e.g. a SmartMeter mounted on the external wall to a bedroom with the bed placed adjacent to that mounting next to the internal wall. That distance is estimated to be one foot. **The CCST Report also states that SmartMeters will generally transmit data once every four hours, and once the grid is fully functional, may transmit "more frequently." It has been aptly demonstrated by computer modeling and real measurement of existing meters that SmartMeters emit frequencies almost continuously, day and night, seven days a week**. **Furthermore, it is not possible to program them to not operated at 100% of a duty cycle (continuously) and therefore it should not be possible to state that SmartMeters do not exceed the time-averaged exposure limi**t. Additionally, **exposure is additive and consumers may have already increased their exposures to radiofrequency radiation in the home through the voluntary use of wireless devices** such as cell and cordless phones, personal digital assistants (PDAs), routers for internet access, home security systems, wireless baby surveillance (baby monitors) and other emerging devices. **It would be impossible to know how close a consumer might be to their limit, making safety a uncertainty with the installation of a mandatory SmartMeter**.

This report will focus on the documented health risks of EMF in general, the relevance of that data to SmartMeters exposure, the established guidelines for RF safety to the public at large, ...

Evidence-based Health Risks of EMFs

[T]here is a large body of research on the health risks of EMFs. Much of the data is concentrated on cell phone usage and as **SmartMeters occupy the same energy spectrum as cell phones and depending on conditions, can exceed the whole body radiation exposure of cell phones** (see Attachment B1, Figure 4). In terms of health risks, the causal factor under study is RF radiation whether it be from cell phones, Wi-Fi routers, cordless phones, or SmartMeters. Therefore **all available, peer-reviewed, scientific research data can be extrapolated to apply to SmartMeters**, taking into consideration the magnitude and the intensity of the exposure.

...

[N]oted by Genuis, 2011 is that **most research carried out by independent non-government or non-industry affiliated researchers suggests potentially serious effects from many non-ionizing radiation exposures**; research funded by industry and some governments seems to cast doubt on the potential for harm. **Elements of the controversy stem from the inability to replicate findings consistently in laboratory animal studies**. However, **analysis of many of the conflicting studies is not valid as the methodology used is not comparable**. Despite this controversy, evidence is accumulating on the results of exposure to RF

at non-thermal levels including **increased permeability of the blood-brain barrie**r in the head (Eberhardt, 2008), harmful effects on sperm, **double strand breaks in DNA** which could lead to cancer genesis (Phillips, 2011), stress gene activation indicating and exposure to a toxin (Blank, 2011), and **alterations in brain glucose metabolism** (Volkow, 2011).

In terms **of meta-analyzed epidemiological studies, all case-control epidemiological studies covering >10 years of cell phone use have reported an increased risk of brain tumors from the use of mobile phones** (Hallberg, 2011). Other studies have pointed to an increasing risk of acoustic neuroma, salivary gland tumors, and eye cancer after several years of cell phone use and the tumors occur predominantly on the same side of the head as the phone is used. The analysis of brain cancer statistics since the mid 20th century in several countries reveals that **brain tumor formation has a long latency time, an average of over 30 years** to develop from initial damage. (Hallberg, 2011). **Therefore using studies** such as the Interphone Study **which looked at shorter latency periods for the development of specific brain cancers will result in inconclusive data**.
...
In 2004, **WHO declared EHS "a phenomenon where individuals experience adverse health effect while using or being in the vicinity of devices emanating electric, magnetic, or electromagnetic fields (EMFs)...Whatever its cause, EHS is a real and sometimes debilitating problem for the affected persons** (Mild et al., 2004)."

Currently, **research has demonstrated objective evidence to support the EHS diagnosis**, defining pathophysiological mechanisms including immune dysregulation in vitro, with increased production of selected cytokines and disruption and dysregulation of catecholamine physiology (Genuis, 2011).

... In an effort to determine the legitimacy of EHS as a neurological disorder ... **a collection of scientists and physicians recently conducted a double-blinded research study that concluded that "EMF hypersensitivity can occur as a bona fide environmentally-inducible neurological syndrome** (McCarty et al., 2011).

Safety Guidelines

The guidelines currently used by the FCC were adopted in 1996, are thermally based, and are believed to protect against injury that may be caused by acute exposures that result in tissue heating or electric shock. **FCC guidelines have a much lower certainty of safety than standards**. **Meeting the current FCC guidelines only assures that one should not have heat damage from SmartMeter exposure**. It says nothing about safety from risk of many chronic diseases that the public is most concerned about such as cancer, miscarriage, birth

defects, semen quality, autoimmune diseases, etc. Therefore, **when it comes to nonthermal effects of RF, FCC guidelines are irrelevant and cannot be used for any claims of SmartMeter safety unless heat damage is involved** (Li, 2011).

There are no current, relevant public safety standards for pulsed RF involving chronic exposure of the public, nor of sensitive populations, nor of people with metal and medical implants that can be affected both by localized heating and by electromagnetic interference (EMI) for medical wireless implanted devices. Many other countries (9) have significantly lower RF/MW exposure standards ... [than] the approximately 600 $\mu W/cm^2$ (time-averaged) allowed for the RFR from SmartMeters operating in the low 900 MHz band mandated by the FCC based on only thermal consideration.

In summary, **there is no scientific data to determine if there is a safe RF exposure level regarding its non-thermal effects**. ... **The two unique features of SmartMeter exposure are: 1) universal exposure** thus far because of mandatory installation ensuring that virtually every household is exposed; **2) involuntary exposure** whether one has a SmartMeter on their home or not due to the already ubiquitous saturation of installation ... . Governmental agencies for protecting public health and safety should be much more vigilant towards involuntary environmental exposures because governmental agencies are the only defense against such involuntary exposure.

[Santa Cruz - End quote]

EXHIBIT 29C-5 (FD):
Letter from Dr. Olle Johansson, PhD, Karolinska Institutet Department of Neuroscience to the California Council on Science and Technology, dated January 17, 2011. Reads in part:

[Johansson letter - Begin quote]

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. (Emphasis added.)

2) ICNIRP/WHO 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.
...
You often hear about "safe levels" of exposure and that there is "no proof of health effects", but my personal response to these seemingly reassuring statements is that it is very important to realize, from a consumer's point of view, that **"no accepted proof for health effects" is not the same as "no risk"**. (Emphasis added.)
...
[I]t shall be noted, that today's recommendation values for wireless systems, the SAR-value, are just recommendations, and not safety levels. **Since scientists observe biological effects at as low as 20 microWatts/kg, is it then really safe to irradiate humans with 2 W/kg (i.e., with 100,000 times stronger radiation!), which is the recommendation level for us?** And, furthermore, it is very strange to see, over and over again, that highly relevant scientific information is suppressed or even left out in various official documents, as high up as at the governmental level of society. (Emphasis added.)

[Johansson letter - End quote]

EXHIBIT 21D-1 (FD):
Order by California Administrative Law Judge, issued October 18, 2011, to PG&E and other IOUs (investor-owned utilities) to produce documentation clarifying the operating characteristics of their AMI smart meter devices.

EXHIBIT 21D-2 (FD):
PG&E documentation including answers to California Administrative Law Judge's questions in response to the ALJ's October 18, 2011 order. PG&E produced documentation on the transmission duty cycle of only the 900-MHz antennas operating inside the company's smart meters. From this documentation, it was determined that the 900-MHz transmitters in these meters could transmit an average of ***9600 RF pulses per meter*** per day and a maximum of ***more than 190,000*** *pulsed* radiation transmissions per 24-hour day. ***90% of these pulses are for 'mesh network message management'***. (p. 5.)

EXHIBIT 29C-6 (FD):
Getting Smarter about the Smart Grid. Presentation of issues concerning exposure to RF radiation and RF electromagnetic fields from smart meters, given at Commonwealth Club of California, Jan. 28, 2014, by physician, biomedical engineer and EMF expert, Dr. Karl H. Maret, MD, MEng.

EXHIBIT 29C-6A (FD):
EMF Health Concerns Associated with RF Metering in California's Smart Grid. Set of Powerpoint slides presented by Dr. Karl Maret, MD, MEng, at Commonwealth Club of California and which are displayed as part of content of **EXHIBIT 29C-6**. https://ecfsapi.fcc.gov/file/7521070429.pdf

EXHIBIT 29C-7A (FD):
Table 1: Scientific Studies Demonstrating Biological Effects at Low Exposure Levels excerpted from the testimony and commentary given by EMF expert, Dr. Karl H. Maret, MD, MEng, to David M. Aaron, Esq., *In the Matter of FortisBC Inc. ... Project No. 3698682*, dated Jan. 23, 2012, and contained in **EXHIBIT 29C-7**.

EXHIBIT 29C-7B (FD):

Diagram 1: Effects of Low intensity Microwave Exposure in various Animals and Human Studies. References to specific studies are listed in Table 1 (**EXHIBIT 29C-7A**) excerpted from the testimony and commentary given by EMF expert, Dr. Karl H. Maret, MD, MEng, to David M. Aaron, Esq., *In the Matter of FortisBC Inc. ... Project No. 3698682*, dated Jan. 23, 2012, and contained in **EXHIBIT 29C-7**. This chart is reproduced as the following graphic:

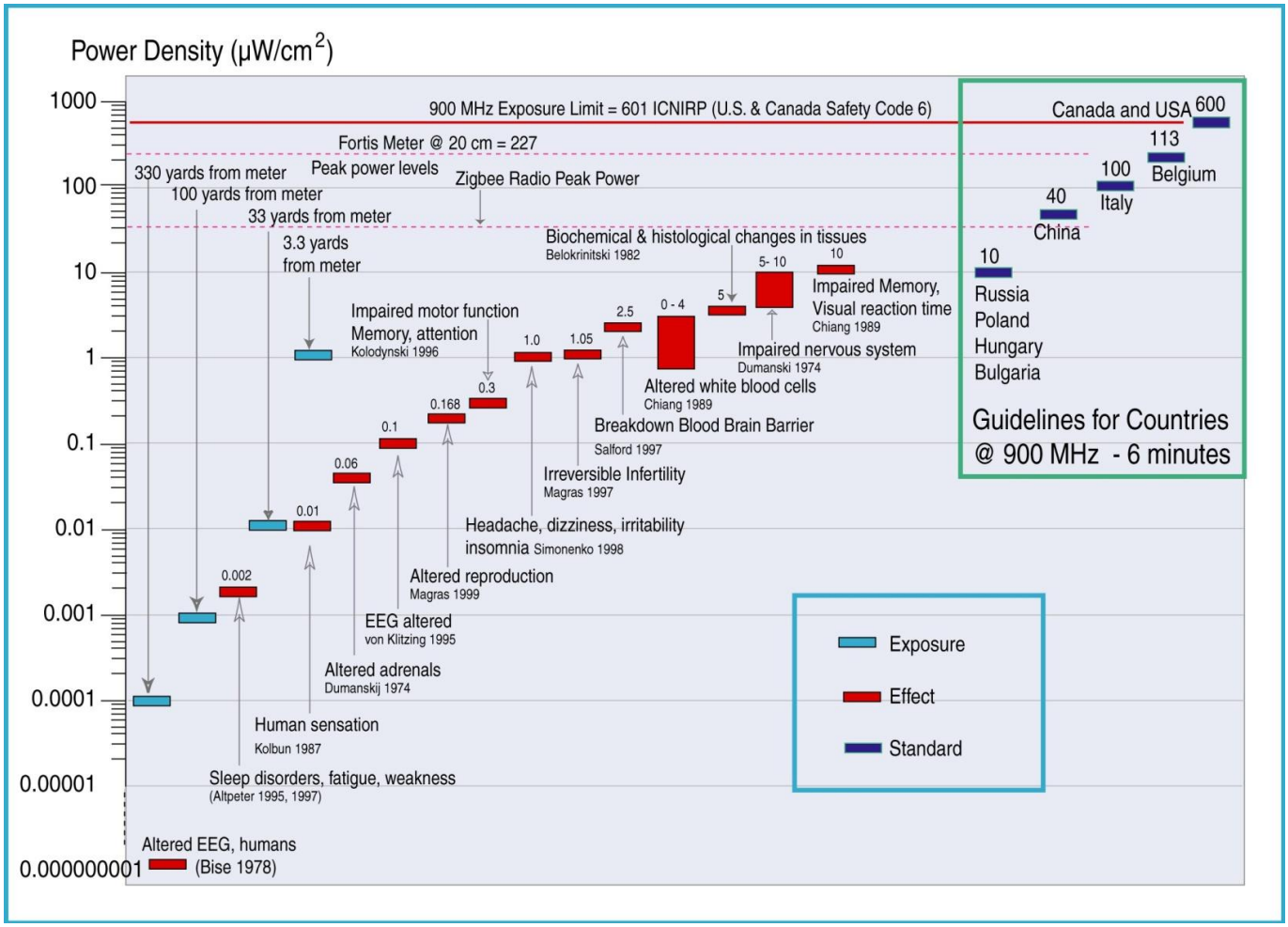

EXHIBIT 29C-8 (FD):

Presentation by EMF expert, Dr. Karl Maret, MD, MEng, given at the Commonwealth Club of California on Jan. 28, 2014. Dr. Maret addresses question concerning what is a safe distance from neighbors' smart meters.

EXHIBIT 29C-9 (FD):

2015 presentation by EMF expert, Dr. Karl Maret, MD, MEng, given at the Commonwealth Club of California, compares RF dosimetry data of Wi-Fi radiation exposures and points to concerns expressed by various medical associations

including the Canadian Medical Association, the American Academy of Pediatrics, and the California Medical Association.

EXHIBIT 29C-10 (FD):
California Medical Association House of Delegates Resolution Wireless Standards Reevaluation 2014 Resolution 107- 14. Resolution adopted by the California Medical Association calling for re-evaluation of the safety standards for wireless communications in the United States.
https://ecfsapi.fcc.gov/file/1020824247004/10%20-%20California%20Medical%20Association%20Resolution-highlighted.pdf

Reads in part:

[CMA - Begin quote]

California Medical Association

House of Delegates Resolution Wireless Standards Reevaluation 2014 Resolution 107- 14
PASSED
Date Adopted Dec 7, 2014

Resolved 1 That CMA supports efforts to reevaluate microwave safety exposure levels associated with wireless communication devices, including consideration of adverse non-thermal biologic and health effects from non-ionizing electromagnetic radiation used in wireless communications; and be it further

Resolved 2 That CMA support efforts to implement new safety exposure limits for wireless devices to levels that do not cause human or environmental harm based on scientific research.

...

Whereas scientists are increasingly identifying EMF from wireless devices as a new form of environmental pollution with a growing body of peer reviewed scientific evidence finding significant adverse health and biologic effects on living organisms with exposure to low levels of non-ionizing microwaves currently approved and used in wireless communication, and

Whereas **peer reviewed research has demonstrated adverse biological effects of wireless EMF 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; and (2-55) (Emphasis added.)

...

Whereas many scientists, researchers, public health officials and agencies conclude that wireless electromagnetic frequency (EMF) standards established by the Federal Communications Commission are outdated as they are based only on heat effects which damage to the organism and not **biological effects of non–ionizing EMF microwave radiation which are scientifically demonstrated at levels hundreds of times less than current safety exposure limits and thus current standards are inadequate to protect public health**; and (49-51)(57) (Emphasis added.)

...

RESOLVED; that the CMA understands that **existing public safety limits for microwave EMF devices are** outdated and **inadequate to protect public health** thus endorses efforts of the Federal Communications Commission to reevaluate its safety standards to include consideration of adverse non thermal biologic and health effects from non ionizing electromagnetic radiation used in wireless communications; (Emphasis added.)

[CMA - End quote]

EXHIBIT 29C-11 (FD):

California Medical Association Calls for Stronger Wireless Communication Safety Standards. April 13, 2015. https://www.saferemr.com/2015/04/california-medical-association-calls.html Reads in part:

[CMA calls - Begin quote]

Cindy Lee Russell, M.D. introduced the resolution which she co-authored along with Ken Yew, M.D.

According to Dr. Russell:

"Physicians and scientists have recognized for years the dangers of ionizing radiation from x rays and nuclear weapons. Tissue is directly damaged causing cancer and a wide range of other health effects. The non ionizing **microwave radiation** from wi fi routers, ipads, cell phones and cell towers has been thought to be harmless until the last few decades as a rapidly growing body of peer reviewed research **has shown very troubling biological and health effects from even low levels of exposure**. The studies have shown negative effects on cell structures, brain function, animals, and plants. Many experts feel this is a looming public health problem as the use of wireless technology swiftly rises in our homes, offices and schools. EMF standards need to be reevaluated and designed for safety

based on the biologic effects on living structures not on heat as is now currently being done." (Underlining and emphasis added.)

[CMA calls - End quote]

EXHIBIT 29C-12 (FD):
Scientists decry Canada's outdated Wi-Fi safety rules. Canadian Medical Association Journal, CMAJ June 16, 2015 187 (9) 639-640; http://www.cmaj.ca/content/187/9/639 https://doi.org/10.1503/cmaj.109-5061

EXHIBIT 29C-13 (FD):
Canadian Medical Association Journal reports Health Canada's wireless limits are "A Disaster to Public Health". newswire.ca, May 7, 2015 (early release). https://www.newswire.ca/news-releases/canadian-medical-association-journal-reports-health-canadas-wireless-limits-are-a-disaster-to-public-health-517706441.html

EXHIBIT 29C-14 (FD):
Report on the review of the California Council on Science and Technology document, "Health Impacts of Radiofrequency from Smart Meters" by Dr. David O. Carpenter, MD, MPH. Reads in part:

[Carpenter on CCST - Begin quote]

This document is not an accurate description of the state of the science on the issue of radiofrequency fields, and is full of inaccuracies.
...
The statement "The potential for behavioral disruption from increase body tissue temperatures is the only biological health impact that has been consistently demonstrated and scientifically proven to result from absorbing RF within the band of the electromagnetic spectrum that smart meters use" is totally wrong. In the first place there are many adverse health effects other than "behavioral disruption" demonstrated as a result of tissue heating. ... There is also strong and consistent evidence for increased risk of leukemia in individuals who live near to high power AM radio transmission towers, even though this report characterizes such exposures as being "quite low" and show in Figure 7 that they are lower than the RF fields from smart meters.
...
The statement "The scientific consensus is that body temperatures must increase at least 1^{o}C to lead to potential biological impacts from the heat" is totally wrong, and

makes it obvious that no persons with medical or biological expertise participated in this report. Every enzyme system in the body is exquisitely sensitive to temperature, and increases activity by even a fraction of a degree increase in temperature. In fact all RF generates heat, and what is defined as "nonthermal" is only a function of our ability to measure the temperature increase.

The statement "While concerns of brain cancer associated with mobile phone usage persist, there is currently no definitive evidence linking cell phone usage with increased incidence of cancer" is incorrect. The evidence is strong and consistent among studies looking at long-term and intensive use of cell phones. ...

The statement "There currently is no conclusive scientific evidence pointing to a non-thermal cause-and-effect between human exposure to RF emissions and negative health impacts is inaccurate, and depends totally on what one defines as conclusive". ...

[Carpenter on CCST - End quote]

EXHIBIT 29C-16 (FD):
Smart Meters: Correcting the Gross Misinformation. Article published by ***La Maison du 21e siecle***, dated June 11, 2012.
https://ecfsapi.fcc.gov/file/7521097472.pdf and
https://maisonsaine.ca/actualites/smart-meters-correcting-the-gross-misinformation.html

This content of this article was affirmed by more that 50 highly-credentialed scientists and medical doctors concerned with biomedical and bioelectromagnetics research and reads in part:

[Correcting the Gross Misinformation - Begin quote]

Quebec-based magazine La Maison du 21e siecle asked physician David O. Carpenter, former founding dean of the University at Albany (NY)'s School of Public Health, to comment an open letter published in the Montreal daily Le Devoir last May 24. This letter claimed wireless smart meters pose no risk to public health. More than fifty international experts contributed to the following rebuttal. (Underlining added.)

We, the undersigned are a group of scientists and health professionals who together have coauthored hundreds of peer-reviewed studies on the health effects of electromagnetic fields (EMFs). We wish to correct some of the gross misinformation found in the letter regarding wireless "smart" meters that was

published in the Montreal daily *Le Devoir* on May 24. Submitted by a group Quebec engineers, physicists and chemists, the letter in question reflects an obvious lack of understanding of the science behind the health impacts of the radiofrequency (RF)/microwave EMFs emitted by these meters.

The statement that « Thousands of studies, both epidemiological and experimental in humans, show no increase in cancer cases as a result of exposure to radio waves of low intensity… » is false (1). In fact, only a few such studies — two dozen case-control studies of mobile phone use, certainly not thousands, have reported no elevations of cancer, and most were funded by the wireless industry. In addition, these reassuring studies contained significant experimental design flaws, mainly the fact that the populations followed were too small and were followed for a too short period of time. (Underlining and emphasis added.)

Non industry-funded studies have clearly demonstrated a significant increase in cancer cases among individuals who have suffered from prolonged exposure to low-level microwaves, transmitted notably by radio antennas. The effects were best documented in meta-analyses that have been published and that include grouped results from several different studies: these analyses consistently showed an increased risk of brain cancer among regular users of a cell phone who have been exposed to microwaves for at least ten years.

...

Well-known bioeffects

While the specific pathways to cancer are not fully understood, it is scientifically unacceptable to deny the weight of the evidence regarding the increase in cancer cases in humans that are exposed to high levels of RF/microwave radiation.

The statement that « there is no established mechanism by which a radio wave could induce an adverse effect on human tissue other than by heating » is incorrect, and reflects a lack of awareness and understanding of the scientific literature on the subject. In fact, more than a thousand studies done on low intensity, high frequency, non-ionizing radiation, going back at least fifty years, show that some biological mechanisms of effect do not involve heat. This radiation sends signals to living tissue that stimulate biochemical changes, which can generate various symptoms and may lead to diseases such as cancer.

Even though RF/microwaves don't have the energy to directly break chemical bonds, unlike ionizing radiation such as X-rays, there is scientific evidence that this energy can cause DNA damage indirectly leading to cancer by a combination of biological effects. Recent publications have documented the generation of free radicals, increased permeability of the blood brain barrier allowing potentially toxic chemicals to enter the brain, induction of genes, as well as altered electrical and

metabolic activity in human brains upon application of cell phone RF/microwaves similar to those produced by smart meters.

These effects are cumulative and depend on many factors including RF/microwave levels, frequency, waveform, exposure time, biovariability between individuals and combination with other toxic agents. Clear evidence that these microwaves are indeed bioactive has been shown by the fact that low-intensity EMFs have proven clinically useful in some circumstances. Pulsed EMFs have long been used to successfully treat bone fractures that are resistant to other forms of therapy. More recently, frequency-specific, amplitude-modulated EMFs have been found useful to treat advanced carcinoma and chronic pain. (Emphasis added.)

High frequency EMFs such as the microwaves used in cell phones, smart meters, Wi-Fi and cordless ‘‘DECT’’ phones, appear to be the most damaging when used commonly. **Most of their biological effects, including symptoms of electrohypersensitivity, can be seen in the damage done to cellular membranes by the loss of structurally-important calcium ions. Prolonged exposure to these high frequencies may eventually lead to cellular malfunction and death**. (Emphasis added.)

...

Smart meters

As Australian Associate Professor of neurosurgery Vini G. Khurana reports, adverse neurological effects have been reported in people who sustain close proximity to wireless meters, especially under 10 feet (3 metres).

A wireless smart meter produces radiofrequency microwave radiation with two antennas in approximately the same frequency range (900 MHz to 2.4 GHz) as a typical cell tower. But, depending on how close it is to occupied space within a home, a smart meter can cause much higher RF exposures than cell towers commonly do. If a smart meter is located on a common wall with a bedroom or kitchen rather than a garage wall, for example, the RF exposure can be the same as being within 200 to 600 feet distance of a cell tower with multiple carriers. **With both cell towers and smart meters, the entire body is immersed by microwaves that go out in all directions, which increases the risk of overexposure to many sensitive organs such as the eyes and testicles.** With a cell phone, people are exposed to microwaves primarily in the head and neck (unless using speaker mode), and only when they use their device. (Emphasis added.)

Wireless smart meters typically produce atypical, relatively potent and very short pulsed RF/microwaves whose biological effects have never been fully tested. They emit these millisecond-long RF bursts on average 9,600 times a day with a maximum of 190,000 daily transmissions and a **peak level emission two**

and a half times higher than the stated safety signal, as the California utility Pacific Gas & Electric recognized before that State's Public Utilities Commission. Thus people in proximity to a smart meter are at risk of significantly greater aggregate of RF/microwave exposure than with a cell phone, not to mention the cumulative exposure received by people living near multiple meters mounted together, pole-mounted routers or utility collector meters using a third antenna to relay RF signals from 500 to 5,000 homes. (Emphasis added.)

A technical study performed by Sage Associates in California indicates that RF levels from various scenarios depicting normal smart meter installation and operation may violate even the out-of-date US public safety standards which only consider acute thermal effects. This can happen when a person stands close to the meter to read the power consumption, or touches it, or shades the meter face with a hand to better read it. Emissions are also increased by reflective materials, such as stainless steel, other metals and mirrors, which can re-radiate stronger that the otherwise unaltered background. Microwaves are absorbed and dissipated by partially conductive materials, such as cement and special RF shielding paints and fabrics.

In addition to the erratic bursts of modulated microwaves emitted by wireless smart meters ... are also a major source of ‘‘dirty electricity’’ (electrical interference of high frequency voltage transients typically of kilohertz frequencies). Some scientists, such as American epidemiologist Sam Milham, believe that many of the health complaints about smart meters may also be caused by **dirty electricity generated by the « switching » power supply activating all smart meters**.

...

1. Scientific papers on EMF health effects
2. Explanation and studies on electrosensitivity
3. Governments and organizations that ban or warn against wireless technology

• David O. Carpenter, MD, Director, Institute for Health & the Environment, University at Albany, USA

• Franz Adlkofer, M.D., Chairman of the Pandora Foundation, Coordinator of the European Reflex Report on DNA-damage by cellphone radiation, Neuendorf, Germany

• M. S. H. Al Salameh, PhD, Professor of Electrical Engineering, University of Science & Technology, Irbid, Jordan

• Jennifer Armstrong, MD, Past President, American Society for Environmental Medicine, Founder, Ottawa Environmental Health Clinic, Ontario, Canada

• Pierre L. Auger, MD, Occupational medicine, Multiclinique des accidentés 1464, Montreal, Quebec, Canada

• Igor Beliaev, PhD, Head research scientist, Cancer Research Institute, Slovak Academy of Sciences, Bratislava, Slovak republic
• Fiorella Belpoggi, PhD, Director Cesare Maltoni Cancer Research Center, Ramazzini Institute, Bologna, Italy
• Dominique Belpomme, MD, Director of the European Cancer and Environment Research Institute, Brussels, Belgium
• Martin Blank, PhD, former President, Bioelectromagnetics Society, Special Lecturer, Department of Physiology and Cellular Biophysics, Columbia University Medical Center, New York, USA
• Barry Breger, MD, Centre d'intégration somatosophique (orthomolecular medicine), Montreal, Quebec
• Simona Carrubba, PhD, Prof. Biophysics, Daemen College, Amherst, NY, Associate Researcher, Neurology, Buffalo General Hospital , Buffalo, NY
• John Cline, MD, Professor, Institute for Functional Medicine, Federal Way, WA, USA, Medical Director, Cline Medical Centre, Nanaimo, BC, Canada
• Alvaro Augusto de Salles, PhD, Professor of Electrical Engineering, Federal University of Rio Grande do Sul, Porto Alegre, Brazil
• Christos Georgiou, Prof. Biochemistry, Biology Department, University of Patras, Greece
• Andrew Goldsworthy, PhD, Honorary lecturer in Biology, Imperial College, London, UK
• Claudio Gómez-Perretta, MD, Director, Centro de Investigación, Hospital Universitario LA Fe, Valencia, Spain
• Livio Giuliani, PhD, Senior Researcher, National Insurance Institute (INAIL), Chief of Radiation and Ultrasounds Research Unit, Rome, Italy
• Yury Grigoriev, PhD, Chair Russian National Committee on Non-Ionizing Radiation Protection, Moscow, Russia
• Settimio Grimaldi, PhD, Director, Institute of Translational Pharmacology (Neurobiology and molecular medicine), National Research Council, Rome, Italy
• Magda Havas, PhD, Centre for Health Studies, Trent University, Canada
• Lennart Hardell, MD, Professor of Oncology, University Hospital, Örebro, Sweden
• Denis L. Henshaw, PhD, Professor of Physics, Head of The Human Radiation Effects Group, University of Bristol, UK
• Ronald B. Herberman, MD, Chairman of Board, Environmental Health Trust, and Founding Director emeritus, University of Pittsburgh Cancer Institute, USA
• Donald Hillman, PhD, Dairy Science, Professor Emeritus, Department of Animal Science, Michigan State University, USA
• Isaac Jamieson, PhD, Environmental Science (electromagnetic phenomena in the built environment), independent architect, scientist and environmental consultant, Hertfordshire, UK
• Olle Johansson, PhD, Professor of Neuroscience (Experimental Dermatology Unit), Karolinska Institute, Stockholm, Sweden

• Yury Kronn, PhD, Soviet authority on physics of nonlinear vibrations and high frequency electromagnetic vibrations, founder of Energy Tools International, Oregon, USA
• Vini G. Khurana, MBBS, Associate of Professor of Neurosurgery, Australian National University, Australia
• Henry Lai, PhD, Professor of Bioengineering, University of Washington School of Medicine, Seattle, WA, USA
• Abraham R. Liboff, PhD, Professor Emeritus, Department of Physics, Oakland University, Rochester, Michigan, USA
• Don Maisch, PhD, Researcher on radiation exposure standards for telecommunications frequency, EMFacts Consultancy, Tasmania, Australia
• Erica Mallery-Blythe, MD, Emergency Medicine Physician, England
• Andrew A. Marino, PhD, Professor of Neurology, LSU Health Sciences Center, Shreveport, LA, USA
• Karl Maret, MD, President, Dove Health Alliance, Aptos, CA, USA
• Fiorenzo Marinelli, PhD, Researcher on biological effects of EMFs, Institute of Molecular Genetics, National Research Council, Bologna, Italy
• Andrew Michrowski, PhD, Director, Planetary Association for Clean Energy, Ottawa, Canada
• Sam Milham, MD, former chief epidemiologist, Washington State Department of Health, USA
• Joel M. Moskowitz, PhD, Director, Center for Family and Community Health, School of Public Health, University of California, Berkeley
• Gerd Oberfeld, MD, Public Health Department, Salzburg State Government, Austria
• Mike O'Carroll, PhD, Professor Emeritus (Applied Mathematics), University of Sunderland, UK
• Jerry L. Phillips, PhD, Director, Center for Excellence in Science, Department of Chemistry and Biochemistry, University of Colorado, USA
• John Podd, PhD, Professor of Psychology (experimental neuropsychology), Massey University, New-Zealand
• William J. Rea, MD, thoracic and cardiovascular surgeon, founder of the Environmental Health Center, Dallas, Tx, USA
• Elihu D. Richter, MD, Professor, Hebrew University-Hadassah School of Public Health and Community Medicine, Jerusalem, Israel
• Leif G. Salford, MD, Senior Professor of Neurosurgery, Lund University, Sweden
• Nesrin Seyhan, MD, Founder and Chair of Biophysics, Medical Faculty of Gazi University, Turkey
• Cyril W. Smith, PhD, lead author of "Electromagnetic Man", retired from Electronic and Electrical Engineering, University of Salford, UK
• Morando Soffritti, MD, Scientific Director of the European Foundation for Oncology and Environmental Sciences "B. Ramazzini" in Bologna, Italy

• Carlos Sosa, MD, surgeon affected by the Microwave syndrome, Medellin, Columbia
• Antoinette "Toni" Stein, PhD, Collaborative on Health and the Environment (CHE-EMF Working Group), Co-Coordinator, Berkeley, CA, USA
• Stanislaw Szmigielski, MD, PhD Professor of Pathophysiology, Consulting Expert, former director of Microwave Safety, Military Institute of Hygiene and Epidemiology, Warsaw, Poland
• Lauraine Vivian, PhD, Senior Lecturer, Primary Health Care Directorate, Faculty of Health Sciences, University of Cape Town, South Africa.
• Bradford S. Weeks, MD, Director, The Weeks Clinic, Clinton, WA, USA
• Stelios A. Zinelis, MD, Vice-President, Hellenic Cancer Society, Cefallonia, Greece

[Correcting the Gross Misinformation - End quote]

EXHIBIT 29C-17 (FD):
Letter, dated January 19, 2012, from the American Academy of Environmental Medicine (AAEM) to the Public Utilities Commission of the State of California (CPUC). Reads in part:

"The Board of the American Academy of Environmental Medicine opposes the installation of wireless 'smart meters' in homes and schools based on a scientific assessment of the current medical literature (references available on request). **Chronic exposure to wireless radiofrequency radiation is a preventable environmental hazard** that is sufficiently well documented to warrant immediate preventative public health action." (Emphasis added.)
...
"The board ... wishes to point out that **existing FCC guidelines for RF safety that have been used to justify installation of 'smart meters' only look at thermal tissue damage and are obsolete, since many modern studies show metabolic and genomic damage from RF and ELF exposures below the level of intensity which heats tissues**. **The FCC guidelines are therefore inadequate for use in establishing public health standards**. **More modern literature shows medically and biologically significant effects of RF and ELF at lower energy densities. These effects accumulate over time, which is an important consideration given the chronic nature of exposure from 'smart meters'**. The current medical literature raises credible questions about genetic and cellular effects, hormonal effects, male fertility, blood/brain barrier damage and increased risk of certain types of cancers from RF or ELF levels similar to those emitted from 'smart meters'. Children are placed at particular risk for altered brain development, and impaired learning and behavior. Further, EMF/RF adds synergistic effects to the damage observed from a range of toxic chemicals." (Emphasis added.)

...

"The Board of the American Academy of Environmental Medicine also wishes to note that the US NIEHS National Toxicology Program in 1999 cited radiofrequency radiation as a potential carcinogen. **Existing safety limits for pulsed RF were termed 'not protective of public health' by the Radiofrequency Interagency Working Group (a federal interagency working group including the FDA, FCC, OSHA, the EPA and others)**. Emissions given off by 'smart meters' have been classified by the World Health Organization International Agency for Research on Cancer (IARC) as a Possible Human Carcinogen. (Emphasis added.)

"Hence, we call for:

- An immediate moratorium on 'smart meter' installation until these serious public health issues are resolved. **Continuing with their installation would be extremely irresponsible**." (Underlining and emphasis added.)

EXHIBIT 29C-18 (FD):

Testimony of attorney Dafna Tachover, Esq., before the Michigan House Energy Policy Committee, May 29, 2018. Ms. Tachover is the founder of *We Are The Evidence*.

EXHIBIT 30A (FD):

Biological Effects from RF Radiation at Low-Intensity Exposure, based on the BioInitiative 2012 Report, and the Implications for Smart Meters and Smart Appliances. Dr. Ronald M. Powell, PhD, Applied Physics, Energy Policy Research Scientist (retired), National Science Foundation and the National Institute of Standards and Technology (NIST). This paper explains and supports the graphic information provided on page 16 of its contents which consists of a chart entitled: *Reported Biological Effects from RF Radiation at Low-Intensity Exposure in Each of the 67 Studies Referenced in the "BioInitiative 2012" Report (Cell Tower, Wi-Fi, Wireless Laptop, and Smart Meter Power Densities*. (**EXHIBIT 30B**.) In this paper, Dr. Powell makes several observations which include:

"A single Smart Meter on a home can produce RF exposure levels that caused the biological effects found in either most or many of the 67 studies, depending on the distance from the Smart Meter."

"A single Smart Meter on a nearest neighbor's home can produce RF exposure levels that caused the biological effects found in many of the 67 studies. A given home may have one to eight nearest neighbors, each with a Smart Meter,

multiplying the total exposure in the given home."

"Most biological effects of RF exposure cannot be sensed by human beings. Examples are the onset of cancer, DNA damage, and fertility effects. One category of effects that can often be sensed includes neurological effects on sleep, memory, learning, and behavior."

"Because the FCC Maximum Permitted Exposure (MPE) limits are at power densities higher than the power densities addressed in all of the 67 studies, those limits provide no protection against the biological effects found in any of the 67 studies, no matter what the source of the RF radiation.

"Further, the FCC Maximum Permitted Exposure limits ***apply to each source of radiation, individually***, ***not to the combined exposure from all sources***. But a person will generally be exposed to radiation from a combination of sources. So the FCC Maximum Permitted Exposure limits not only are too high to protect a person from a single source of radiation, but also do not consider the actual exposure received by a person from multiple sources of radiation." (Underlining and italics added.)

EXHIBIT 30B (FD):

*Reported Biological Effects from RF Radiation at Low-Intensity Exposure in Each of the 67 Studies Referenced in the "BioInitiative 2012" Report (Cell Tower, Wi-Fi, Wireless Laptop, and **Smart Meter** Power Densities*. Graphic produced by Dr. Ronald Powell, PhD, Applied Physics, Energy Policy Research Scientist (retired), National Science Foundation and the National Institute of Standards and Technology (NIST). This chart is contained on page 16 of **EXHIBIT 30A** and is reproduced as the following graphic:

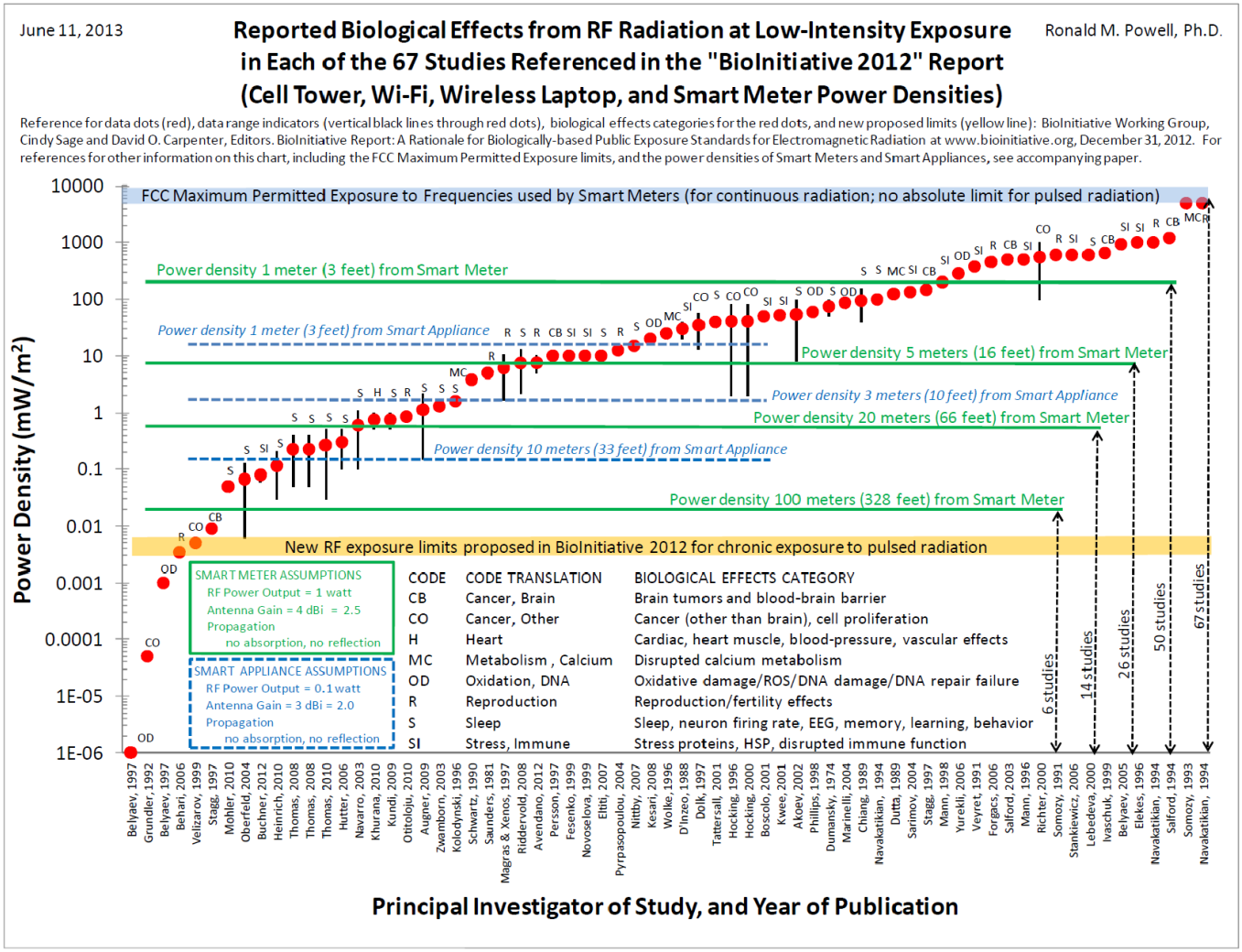

EXHIBIT 30C (FD):

Comparison of RF Standards, Typical Exposures, and Some Reported Effects. Graphic from Kopald & Philips, 2013.

EXHIBIT 30D (FD):
Table of *Reported Biological Effects* associated with radiofrequency radiation at levels below federal guidelines. Studies are listed from top to bottom in order of increasing RF power densities. **Seven of the studies listed reported biological effects at levels of RF exposure less than one one-hundred-millionth** (1/100000000, or 0.00000001) **of the FCC guideline** of 1000 microwatts per square centimeter.

EXHIBIT 30E (FD):
Letter from U.S. Food and Drug Administration Jefferson Laboratories, National Center for Toxicological Research to National Toxicology Program, National Institute for Environmental Health Sciences, NIEHS, dated May 19, 1999.
https://ntp.niehs.nih.gov/ntp/htdocs/chem_background/.../wireless051999_508.pdf

Reads in part:

"[U]se of wireless communications devices (e.g., cellular phones) is increasing rapidly. **FDA concluded over five years ago that little was known about the possible health effects of repeated or long-term exposure to low levels of RFR of the types emitted by such devices**. However, **some scientific articles suggest a potential cancer risk may exist**." (Underlining and emphasis added.)
...
"**It is not scientifically possible to guarantee those non-thermal levels of microwave radiation ... will not cause long-term adverse health effects**." (Underlining and emphasis added.)
...
"Along with investigations carried out *in vitro*, a number of *in vivo* investigations have also been performed. Of particular interest is, for example, the study conducted by Szmigielski et al (1983), who observed faster development of benzo(a)pyrene-induced skin tumors in mice that were exposed for some months to sub-thermal 2450 MHz microwave radiation.

"Also of interest is a study where 100 rats were exposed from 2 to 27 months of age to pulsed microwave radiation (0.4 W kg-1) (Guy et al, 1985). The exposed group had a significant increase in primary malignant lesions compared with the control group when lesions were pooled regardless of their location in the body, but no single type of malignant tumor was enhanced. Overall the incidence of primary malignancies was similar to that reported elsewhere in rats of this type. If the incidence of primary malignant lesions was pooled without regard to site or cause of death, however, the exposed group had a significantly higher incidence compared with the control group. Also, primary malignancies occurred early in the exposed group compared with the sham exposed group."

EXHIBIT 31D (FD):
Smart Meters and EMR: Health Crisis of Our Time. Dr. Dietrich Klinghardt, MD, PhD. Beginning at 6:35 minute-mark, Dr. Klinghardt asserts: "Probably among all the things I've been discussing, the smart meter is number one in terms of devastation to our system." At 10:24, Dr. Klinghardt, refers to evidence based upon hematological (serum blood) lab test results which is sufficiently conclusive for him to state: "It is our experience as physicians that *everybody* is equally electro-sensitive. If you install [a smart meter], ***measurably***, certain things in your health go down." Although physical signs and symptoms from exposure to smart meter radiation can continue unnoticed, *the health of all exposed persons—not merely some small percentage—is being adversely affected*, as can or could be directly measured from their lab test results. Dr. Klinghardt enumerates some of the sensitivity parameters, which serum blood tests show, significantly increase or undergo abrupt abnormalization from the time of initial exposure to RF radiation following smart meter installation. Several of these parameters include:

1. TGF-Beta 1 (inflammatory marker: significant increase)
2. MMP-9 (metalloproteinase—inflammatory marker: significant increase)
3. Serum copper levels (significant increase)
4. Hormone abnormalization
5. Neurotransmitter abnormalization

EXHIBIT 31E (FD):
Irradiated: A comprehensive compilation and analysis of the literature on radiofrequency fields and the negative biological impacts of non-ionizing electromagnetic fields (particularly radiofrequency fields) on biological organisms

EXHIBIT 32A (FD):
American Academy of Pediatrics letter to U.S. Congressman Dennis Kucinich. Reads in part:

"Children are disproportionately affected by environmental exposures, including cell phone radiation. The differences in bone density and the amount of fluid in a child's brain compared to an adult's brain could allow children to absorb greater quantities of RF energy deeper into their brains than adults. It is essential that any new standards for cell phones or other wireless devices be based on protecting the youngest and most vulnerable populations to ensure they are safeguarded through their lifetimes." ...

"Despite these dramatic changes in mobile phone technology and behavior, the FCC has not revisited the standard for cell phone radiation exposure since 1996. ...

Although wireless devices sold in the United States must ensure that they do not exceed the maximum allowable SAR limit when operating at the device's highest possible power level, concerns have been raised that long-term RF energy exposure at this level affects the brain and other tissues and may be connected to types of brain cancer, including glioma and meningioma." ...

"[R]esearch identified by the GAO demonstrates the need for further research on this issue, and makes clear that exposure standards should be reexamined.

"The GAO concluded that the current exposure limits may not reflect the latest research on RF energy, and that current mobile phone testing requirements may not identify maximum RF energy exposure."

EXHIBIT 32B (FD):
International Appeal to the U.N. and the World Health Organization by Scientists Calling for Protection from Non-ionizing Electromagnetic Field Exposure. European Journal of Oncology, December 2015. **As of August 30, 2018, 244 EMF scientists from 41 nations have signed this appeal**.

EXHIBIT 32C (FD):
International Scientists' Appeal on Risks of Electromagnetic Fields Presented to the United Nations 2015.

EXHIBIT 32D (FD):
Hundreds of Scientists Sign Appeal to the WHO for Protection from EMF Exposure. Environmental Health Trust.

EXHIBIT 33A (FD):
EUROPAEM EMF Guideline 2016 for the prevention and treatment of EMF-related health problems and illnesses. European Academy for Environmental Medicine (EUROPAEM) – EMF working group:

***Corresponding author: Gerd Oberfeld,** Department of Public Health, Government of Land Salzburg, Austria
Igor Belyaev: Cancer Research Institute BMC, Slovak Academy of Science, Bratislava, Slovak Republic; and Prokhorov General Physics Institute, Russian Academy of Science, Moscow, Russia
Amy Dean: American Academy of Environmental Medicine, Wichita, KS, USA
Horst Eger: Association of Statutory Health Insurance Physicians of Bavaria, Medical Quality Circle "Electromagnetic Fields in Medicine – Diagnostic, Therapy, Environment", no. 65143, Naila, Germany

Gerhard Hubmann: Center for Holistic Medicine "MEDICUS", Vienna, Austria; and Wiener Internationale Akademie fur Ganzheitsmedizin (GAMED), Vienna, Austria
Reinhold Jandrisovits: Medical Association Burgenland, Environmental Medicine Department, Eisenstadt, Austria
Markus Kern: Medical Quality Circle "Electromagnetic Fields in Medicine – Diagnosis, Treatment and Environment", Kempten, Germany; and Kompetenzinitiative zum Schutz von Mensch, Umwelt u. Demokratie e.V., Kempten, Germany
Michael Kundi and Hanns Moshammer: Institute of Environmental Health, Medical University Vienna, Vienna, Austria
Piero Lercher: Medical Association Vienna, Environmental Medicine Department, Vienna, Austria
Kurt Müller: European Academy for Environmental Medicine, Kempten, Germany
Peter Ohnsorge: European Academy for Environmental Medicine, Wurzburg, Germany
Peter Pelzmann: Department of electronics and computer science engineering, HTL Danube City, Vienna, Austria
Claus Scheingraber: Working Group Electro-Biology (AEB), Munich, Germany and Association for Environmental- and Human-Toxicology (DGUHT), Wurzburg, Germany
Roby Thill: Association for Environmental Medicine (ALMEN), Beaufort, Luxembourg

Reads in part:

"Studies, empirical observations, and patient reports clearly indicate interactions between EMF exposure and health problems."
...
"On the one hand, **there is strong evidence that long-term exposure to certain EMFs 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."
...
"**Biological and health-relevant effects at non-thermal levels have been shown and discussed by many research groups all over the world** (9, 10, 22–24).

"The ICNIRP recommendations were adopted by the EU in its Council Recommendation of 1999, without
considering long-term non-thermal effects. However, it should be stressed that at an international EMF conference in London (2008), Professor Paolo Vecchia, **ICNIRP** Chairman from 2004 to 2012, 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'* (25).

"For all RF-based non-thermal EMF effects, SAR estimates are not an appropriate exposure metric, but instead either the **field intensity or power density (PD) in combination with exposure duration should be used in safety standards** (26, 14, 27). In contrast to the ICNIRP guidelines, the Russian safety standards, are based on non-thermal RF effects, which were obtained by several research

institutes in the former Soviet Union during decades of studies on chronic exposures to RF (28, 29)."

...

"While biophysical and biochemical mechanisms of biological effects of EMF at low-intensity levels are not exactly known, significant progress has been achieved in the last decades, and there are numerous data indicating that these mechanisms may overlap for ELF and RF effects (13–18)."

...

"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 (ELF MF) as possibly carcinogenic to humans (Group 2B) in 2002 (30) and radio-frequency radiation in 2011 (24).

"It should be noted that, during the last 20 years, more than 20 position papers and resolutions regarding EMF and health have been adopted by EMF researchers and physicians. These include the Vienna EMF Resolution, Austria, 1998; Stewart Report, UK, 2000; Salzburg Resolution, Austria, 2000; Freiburg Appeal, Germany, 2002; Catania Resolution, Italy, 2002; Irish Doctors' Environmental Association Statement, Ireland, 2005; Helsinki Appeal, Finland, 2005; Benevento Resolution, Italy, 2006; Venice Resolution, Italy, 2008; Porto Alegre Resolution, Brazil, 2009; Russian National Committee on Non-Ionizing Radiation Protection Resolution, Russia, 2001; International Doctors' Appeal, Europe, 2012; and the Report of the Standing Committee on Health, Canada, 2015 (31–34).

"In August 2007 and December 2012, the BioInitiative Working Group, an international group of 29 experts with different competences, published two groundbreaking reports "BioInitiative 2007/resp. 2012 – A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)" edited by Cindy Sage and David O. Carpenter, calling for preventive measures against EMF exposure based on the available scientific evidence (9, 10). **The BioInitiative reports are global milestones with respect to a comprehensive review of biological effects and health effects of low-intensity electromagnetic radiation as well as the conclusions and recommendations given for the public**. The BioInitiative report 2012 includes sections on the evidence for effects on: gene and protein expression, DNA, immune function, neurology and behavior, blood-brain barrier, brain tumors and acoustic neuromas, childhood leukemia, melatonin, Alzheimer's disease, breast cancer, fertility and reproduction, fetal and neonatal disorders, autism, disruption by the modulating signal, EMF medical therapeutics, as well as sections on: statement of the problem, the existing public exposure standards, evidence for inadequacy of the standards, the precautionary principle, global public health examples, key scientific evidence and public health recommendations, and summary for the public and conclusions.

"As it is mostly neglected as a health hazard, the European Environment Agency compared the risks of non-ionizing radiation (EMF) to other environmental hazards such as asbestos, benzene, and tobacco, urgently recommending to implement a precautionary approach regarding EMF (35). This position was confirmed and elaborated more comprehensibly in further publications in 2011 and 2013 (36, 37).

"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 (38). This was further strengthened in the European Parliament resolution of April 2009 (39).

"At the meeting in November 2009 in Seletun, Norway, a scientific panel adopted a Consensus Agreement that recommends **preventative and precautionary actions** that **are warranted now, given the existing evidence for potential global health risks from EMF exposure** (40)." (Emphasis added.)

EXHIBIT 33B (FD):
The potential dangers of electromagnetic fields and their effect on the environment. Council of Europe Parliamentary Assembly, Committee on the Environment, Agriculture and Local and Regional Affairs. Doc. 12608. Reads in part:

"One must respect the precautionary principle and revise the current threshold values; **waiting for high levels of scientific and clinical proof can lead to very high health and economic costs**, as was the case in the past with asbestos, leaded petrol and tobacco."
...
"The precautionary principle and the right to a healthy environment, particularly on behalf of children and
future generations, must be key factors in all economic, technological and social development of society."
...
"After **analysing the scientific studies available to date, and also following the hearings for expert opinions** organised in the context of the Committee on the Environment, Agriculture and Local and Regional Affairs, **there is sufficient evidence of potentially harmful effects of electromagnetic fields on fauna, flora and human health to react and to guard against potentially serious environmental and health hazards**." (Underlining and emphasis added.)

EXHIBIT 33C (FD):
Late Lessons From Early Warnings: Towards realism and precaution with EMF? David Gee, European Environment Agency. Reads in part:

"This 'power of the prevailing paradigm' is relevant to the current controversy over mobile phones, where the dominant view of WHO, the EU, and many others is that EMF-RF (radio frequency) energy has to be sufficiently large to cause the heating of biological tissue if it is to cause significant harm [13–15]. The current ICNIRP guidelines for limiting unacceptable RF exposures are derived from this paradigm and are therefore:

based on short term, immediate health effects, such as stimulation of peripheral nerves . . . and elevated tissue temperatures [13].

"This majority view is opposed by those who think that much lower levels of EMF have the potential to cause harm via their capacity to disturb cell signalling or stress response systems that use very small changes in electro-magnetic fields [16–19]."
...
"It can be difficult to accept that something is happening if you do not understand how it can be happening. A major reason why some scientists hang on to their preferred paradigm when evidence against it is mounting is that they need not only to observe a strong association between a cause and an effect but also to understand the mechanisms of biological action that link them. However, this can take decades."
...
"Such a long **time lag between acknowledging compelling associations and understanding their mechanisms of action** is a common feature of scientific inquiry, **as illustrated by many of the case studies in the EEA report. Biological and ecological understanding about exactly how these exposures caused harm is still absent, decades after the associations were accepted as sufficient to justify preventive actions**." (Underlining and emphasis added.)
...
"Despite this lack of mechanistic knowledge, and a general lack of corroborating animal evidence, the **International Agency for Research on Cancer (IARC-WHO) recognised ELF from such magnetic fields as possibly carcinogenic** in 2002, **based on more than 30 positive epidemiological studies** which had been completed since the first "early warning" observation in 1979 [24]. ... However, **recent animal and human evidence seems to be filling some of this knowledge gap** [25]." (Emphasis added.)
...
"The capacity of "homo sapiens" (who should perhaps be called, with less hubris, 'homo stupidus' as few, if any other species, consciously destroy their habitats) to

foresee and forestall disasters, appears to be limited, as the EEA reports on late lessons illustrate.

"Societies could, however, with more humility in the face of uncertainty and ignorance, heed the late lessons and, aided by a wider, yet wise application of the precautionary principle, anticipate and minimise hazards."
...
"Three main scenarios seem to face us with EMF, particularly with the RF from mobile phones. The first is similar to the case studies in the EEA reports on late lessons, where much avoidable harm was not prevented. ... The second is where precautionary actions to reduce EMF exposures avert much potential harm ... ."

EXHIBIT 33D (FD):
Late lessons from early warnings: towards precaution and realism in research and policy. David Gee, Martin Paul Krayer von Krauss. Water Sci Technol (2005) 52 (6): 25-34. PMID: 16304931 (Abstract). https://doi.org/10.2166/wst.2005.0147
Reads in part:

"This paper focuses on the evidentiary aspects of the precautionary principle. Three points are highlighted: (i) the difference between association and causation; (ii) how the strength of scientific evidence can be considered; and (iii) **the reasons why regulatory regimes tend to err in the direction of false negatives rather than false positives**. The point is made that because obtaining evidence of causation can take many decades of research, **the precautionary principle can be invoked to justify action when evidence of causation is not available, but there is good scientific evidence of an association between exposures and impacts**. It is argued that **the appropriate level of proof is context dependent**, as "appropriateness" is based on value judgements about the acceptability of the costs, about the distribution of the costs, and **about the consequences of being wrong**. A complementary approach to evaluating the strength of scientific evidence is to focus on the level of uncertainty. ... [I]t is often disregarded that **the Bradford Hill criteria for evaluating evidence are *asymmetrical*, in that the applicability of a criterion increases the strength of evidence on the presence of an effect, but the inapplicability of a criterion does not increase the strength of evidence on the absence of an effect.** The paper discusses **the reason why there are so many examples of regulatory "false negatives" as opposed to "false positives"**. Two main reasons are put forward: (i) the **methodological bias** within the health and environmental sciences; and (ii) the **dominance within decision-making of short term economic and political interests**." (Underlining and emphasis added.)

EXHIBIT 33E (FD):

Setting Prudent Public Health Policy for Electromagnetic Field Exposures. Dr. David O. Carpenter, MD, Institute for Health and the Environment, University at Albany, Rensselaer, New York, Cindy Sage, Sage Associates, Santa Barbara, CA. Reviews on Environmental Health, Volume 23, No. 2, 2008. Reads in part:

[Prudent Public Health Policy - Begin quote]

KEY FALLACIES AND ANSWERS IN THE DEBATE OVER ELECTROMAGMETIC FIELDS EVIDENCE

The evidence for elevated risk of childhood leukemia from exposure to power-line frequency EMF is weak and inconsistent

Only a small number of children are affected

The risk is low

The evidence that adult diseases are secondary to 50/60 Hz EMF exposure is insufficient

There is little evidence that low-intensity RF fields pose human health hazards

There is no animal evidence

We do not know the mechanism

...

LEVELS OF PROOF AND STANDARDS OF EVIDENCE FOR DECISION-MAKING DIFFER AMONG PROFESSIONS

The levels of proof that are required for general acceptance vary among the disciplines. The level of proof that should trigger a public health response does not, and should not, require the same level of proof as that required for proof of a mathematical theorem or a basic principle in biology. The principal reason that the levels of proof are different in these situations is that in the case of public health, an enormous cost, in terms of human life lost, in doing nothing could be involved.

...

The level of proof used by the biology and medical scientific community is that the associations from experimental animal and cell studies and from human epidemiologic studies are established such that no more than a 5% possibility remains that the results could be due to chance.

...

When evaluating the findings of statistically significant relations between EMF exposure and disease in relation to the considerations outlined by Hill, the evidence for leukemia in children is sufficiently strong to meet the criteria. The associations of disease with adult leukemia and brain tumors and for the neurodegenerative diseases Alzheimer’s disease and ALS is certainly less extensive, but still sufficient to meet most of the criteria. The evidence for the adverse effects of RF exposure, although growing rapidly, is not as complete but is still strongly suggestive. Thus,

the question remains of how to deal with evidence that is incomplete, but for which the public health impact is potentially great.

The legal profession looks at the burden of proof and standards for judging the evidence in a far different way. The level of proof that is the standard applied in civil legal proceedings is ‘more likely than not’. In other words, if there is a 50%+ likelihood of harm, then this level is taken as evidence for a relation, as shown in Figure 2. It is not necessary that the evidence of harm be conclusive, neither is some uncertainty of causation a reason to conclude that no relation exists between exposure and harm. In fact, a certain amount of uncertainty is allowable, even under the more stringent (criminal) standard of evidence, namely “beyond a reasonable doubt”. No legal standard requires complete certainty of effect to make a defensible judgment on the evidence at hand. The level of certainty about an effect that is sufficient to take action (in this case to decide the admissibility of evidence or the outcome of a court trial) can be lower than a strictly scientific determination on causality. Important social issues must often be decided based on uncertain scientific evidence. This level of evidence has been more than reached for the association between prolonged and frequent use of cell phones and increased risk of ipsilateral brain tumors, acoustic neuromas, and parotid gland tumors.

Prudent public health policy requires yet a different approach to standards of evidence, based on precaution (far right bar in Figure 2). A large difference can be seen between what constitutes causal evidence for purposes of achieving scientific consensus, what constitutes "a more likely than not" case under the law, and what constitutes sufficient evidence for purposes of interim public health policy. **The demonstration of a low level of proof of an environmental hazard, especially if there is a potential for a significant public health impact, should warrant preventative action and mitigation of impacts**. Furthermore, the threshold for and the degree of action should vary with the magnitude of the potential impact on human health. (Underlining and emphasis added.)

A central confusion in this debate has been whether prudent environmental policy and public health decisions necessarily require conclusive scientific evidence to first be demonstrated. We do not believe that this is the case. The state of the science needs to be presented in an understandable and scientifically accurate manner, but **prudent public health actions do not and should not require proof of harm at any level described above. When some evidence for danger that may lead to significant harm is reported, taking preventative actions and implementing policies that are protective of public health, safety, and welfare rather than waiting for absolute scientific certainty may be essential**. (Emphasis added.)

...

"When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relations are not fully established scientifically. **In this context the proponent of an activity, rather than the public, should bear the burden of proof**. The process of applying the Precautionary Principle must be open, informed, and democratic and must include potentially affected parties. ..." (Underlining and emphasis added.)

The Precautionary Principle does not include a focus on economic factors, but rather implies that caution should be exercised in all decisions affecting human exposures. This principle is a formulation of ... "An ounce of prevention is worth a pound of cure."

In the case of power-frequency and RF EMF, the sheer numbers of people who are at risk makes the wise handling of this issue a health policy imperative. **In the face of inadequate evidence, the public health response should be proportional to the potential public health impact** (Figure 4). It may be true that the risk to any one individual is not great, but from a societal perspective, the impact of exposure may be very large. Proof of harm should not be a pre-condition for taking action when the potential health impact is huge. What decision-makers need to address is what standard of evidence is appropriate now to guide them with respect to EMF exposures that are clearly of environmental and public health concern. The prudent approach from a public health point of view is to take preventive actions as if causation had been proven, while at the same time to continue to search for mechanisms of action. **The fact that there are unknowns does not negate or override the ultimate public health responsibility, which is to protect the population from exposures that cause disease**. (Emphasis added.)
...
The evidence for hazards to human health from both ELF and RF EMF is sufficiently strong as to merit immediate steps to reduce exposure. (Emphasis added.)
...
The proposals presented here reflect the evidence that a positive assertion of safety cannot be made with respect to chronic exposure to low-intensity levels of ELF and RF radiation. (Underlining and emphasis added.)

[Prudent Public Health Policy - End quote]

EXHIBIT 34B (FD):
Evidence for Stress Response (Stress Proteins) - Health Risk of Electromagnetic Fields: Research on the Stress Response. Dr. Martin Blank, PhD, Department of Physiology and Cellular Biophysics, College of Physicians and Surgeons, Columbia University. On pages 14 and 15, Dr. Blank again clearly articulates the

fact that **'scientific proof' does *not* rely on an adversarial 'weight of the evidence'** and that negative study results, rather than being utilized primarily to further refine experimental analysis and design in pursuit of knowledge, are instead being used inappropriately as a kind of scorekeeping tool merely for the purpose of neutralizing or negating the results of positive studies. Reads in part:

[Blank 'Stress Proteins' - Begin quote]

The stress response is a protective cellular mechanism that is characterized by stress protein synthesis. **The stress response, by its very nature, shows that *cells react to EMFs as potentially harmful***. The stress response is an important protective mechanism that enables cells from animals, plants and bacteria to survive environmental stressors with the aid of heat shock proteins (hsp). **It is stimulated by both non-thermal power (ELF), and non-thermal radiofrequency (RF) as well as thermal radio (RF) frequency EMFs, so the greatly differing energies are not critical in activating the DNA to synthesize proteins**. Direct interaction of both ELF and RF EMFs with DNA is likely, since specific DNA sequences are sensitive to EMFs and retain their sensitivity when transferred to artificial molecular constructs. ... **There is ample evidence that ELF and RF fields activate DNA in cells and cause damage at exposure levels that are considered 'safe' (i.e., below current exposure limits that are based on tissue heating as measured in Specific Absorption Rate or SAR**). Because non-thermal EMFs are biologically active and potentially harmful, new safety standards must be developed to protect against possible damage at non-thermal levels, and the standards must be defined in terms of a non-thermal biological dose. Fewer than one quarter of the relevant references listed in Table 1 appear in the IEEE list leading to the newly revised IEEE C95.1 recommendations (April, 2006).

Stress Proteins - Conclusions (Heat Shock Proteins)

Conclusion: Scientific research has shown that the public is not being protected from potential damage that can be caused by exposure to EMF, both power frequency (ELF) and radio frequency (RF).

Conclusion: DNA damage (e.g., strand breaks), a cause of cancer, occurs at levels of ELF and RF that are below the safety limits. Also, there is no protection against cumulative effects stimulated by different parts of the EM spectrum.

Conclusion: The scientific basis for EMF safety limits is flawed when the same biological mechanisms are activated in ELF and RF ranges at vastly different levels of the Specific Absorption Rate (SAR). ***Activation of DNA to synthesize stress proteins (the stress response), is stimulated in the ELF at a non-thermal***

SAR level that is over a billion times lower than the same process activated in the RF at the thermal level. (Underlining and emphasis added.)

Conclusion: There is a need for a biological standard to replace the thermal standard and to also protect against cumulative effects across the EM spectrum.

...

DNA activation mechanisms: EMFs and electrons

We think of DNA as a very stable polymer that stores and transmits genetic information from generation to generation. However, DNA must also come apart relatively easily to enable the continuous protein synthesis that is needed to sustain living cells. Usually, this process is started when specialized proteins called transcription factors bind to DNA.

However, both ELF and RF fields also stimulate DNA to start protein synthesis. EMF stimulation of stress protein synthesis indicates activation of DNA, even by relatively weak non-thermal ELF. This raises the possibility that EMF can cause other changes in DNA that interfere with the copying and repair processes in DNA, and that can lead to mutations and cancer.

... Since recent research has shown electron conduction in DNA (Wan et al, 1999; 2000; Ratner, 1999; Porath et al, 2000; Giese and Spichty, 2000), it is possible that EMF affects electron distribution and movement in DNA, and helps it to come apart to initiate protein synthesis ... . Charge transport through DNA depends on the DNA sequence (Shao et al, 2005), and there are reasons to believe that EMFs would cause the DNA to come apart at the EMF consensus sequence, nCTCTn (Blank and Goodman, 2002).

The ability of relatively small perturbations to stimulate DNA to initiate biosynthesis is consistent with larger perturbations that lead to DNA strand breaks. Several experimental studies have reported both single and double strand breaks in DNA and other chromosome damage after exposure to ELF fields (Lai and Singh, 1997a; Ivancsits et al, 2005, Diem et al, 2005; Winker et al, 2005). Ivancsits et al (2005) found DNA damage in fibroblasts, melanocytes and rat granulosa cells, but not in lymphocytes, monocytes and skeletal muscle cells. **Single and double strand breaks and other DNA damage after exposure to RF fields have also been reported** (Phillips et al, 1998; Sarimov et al, 2004; Lai and Singh, 2005). (Underlining and emphasis added.)

The Ivancsits, Diem and Winker studies cited above are part of the REFLEX Project, **a collaboration of twelve laboratories in seven countries of the European Union** (REFLEX, 2004). The group **found that both ELF and RF exposures, below the current safety limits, modified the expression of many**

genes and proteins. They also reported DNA damage (e.g., strand breaks, micronuclei, chromosomal damage) due to ELF fields at exposures of 35μT. Similar genotoxic effects were produced in fibroblasts, granulosa cells and HL60 cells by RF fields at SARs between 0.3 and 2W/kg. The expression and phosphorylation of the stress protein hsp27 was one of the many proteins affected.

...

Scientific research is designed to answer questions, and answers do not come from deciding *a priori* that certain types of studies are not relevant or can be ignored because they have not been adequately proven in the eyes of the organizers. Scientific method is not democratic. The word 'proof' in **'scientific proof'** is best understood in terms of its older meaning of 'test'. It **does not rely on an adversarial 'weight of the evidence'**, **where opposing results and arguments are presented and compared**. **Answers do not come from keeping a scoreboard of positive versus negative results and merely tallying the numbers to get a score**. **In scientific proof, number and weight do not count**. It is hard to see how the review in *Bioelectromagnetics* Supplement 6 could reconcile its advocacy of science as a guiding principle with its subsequent endorsement of "the weight of evidence approach" to be used in their assessment.

We should be reminded that 'scientific proof' is not symmetric (Popper, 1959). One cannot prove that EMF is harmless no matter how many negative results one presents. ***One single reproducible (significant) harmful effect would outweigh all the negative results***. (Emphasis added.)

The above characteristics of science are generally acknowledged to be valid as abstract principles, but **in EMF research, it has been quite common to list positive and negative findings and thereby imply equal weights**. Table 1 is an alphabetical listing by first author of positive and negative findings, with the negative studies indicated as **NO** in bold. There is no scoreboard, since the studies are on many different systems, etc, and not of the same quality. The listing is not meant to be complete or to be scored, but rather to present the variety of biological systems studied in the different EMF ranges. **Negative studies play an important role in science, and there is good reason to publish them when they are failures to replicate earlier positive results**. This can often lead to important clarifications of the effect, the technique, etc. **However, negative studies are being used in another way. Although they cannot prove there is no positive effect, they do have an influence in the unscientific 'weight of evidence approach'**. In epidemiology, where it is difficult to compare studies done under different conditions, it is common to make a table of the positive and negative results. The simple listing has the effect of a tally, and the overall score substitutes for an evaluation. In any case, **one can write that the evidence is 'not consistent', 'not convincing' or claims are 'unsubstantiated' and therefore 'unproven'**. The

same is true in experimental studies. Funds are generally not available for an independent study to track down the causes of the differences in results, so the **contradictory results are juxtaposed and a draw is implied. This is a relatively cheap but effective way to neutralize or negate a positive study**.

...

It is generally agreed that EMF safety standards should be based on science, yet recent **EMF research has shown that a basic assumption used to determine EMF safety is not valid**. The safety standard assumes that EMF causes biological damage only by heating, but cell damage occurs in the absence of heating and well below the safety limits. This has been shown in the many studies, including the cellular stress response where cells synthesize stress proteins in reaction to potentially harmful stimuli in the environment, including EMF. **The stress response to both the power (ELF) and radio (RF) frequency ranges shows the inadequacy of the thermal (SAR) standard**. (Underlining and emphasis added.)

[Blank 'Stress Proteins' - End quote]

EXHIBIT 34C-1 (FD):

Protein and DNA Reactions Stimulated by Electromagnetic Fields. Dr. Martin Blank, PhD. Electromagnetic Biology and Medicine, 27: 3–23, 2008. DOI: 10.1080/15368370701878820. Reads in part:

"Studies with electric and magnetic fields in the extremely low-frequency range have shown that weak fields can cause charge movement. It has also been known for some time that redistribution of charges in large molecules can trigger conformational changes that are driven by large hydration energies. This review considers examples of direct effects of electric and magnetic fields on charge transfer, and structural changes driven by such changes. Conformational changes that arise from alterations in charge distribution play a key role in membrane transport proteins, including ion channels, and probably account for DNA stimulation to initiate protein synthesis. It appears likely that weak EMF can control and amplify biological processes through their effects on charge distribution."

...

"In the past, a frequent criticism of experimental EMF studies describing biological changes has been the absence of a mechanism to account for the effects of weak EMF. The absence of a theoretical framework was often presented as an indication that the results were not possible. Despite the clear experimental evidence of repeatable biological effects, this point of view was made to sound plausible by the relatively large energy demands of the biological phenomena ascribed to stimulation by weak EMF. The present proposal indicates a huge energy source that can account for many biological phenomena, including those stimulated by EMF."

EXHIBIT 34D (FD):
Electromagnetic Fields and Health Risk—A Scientific Perspective. Dr. Martin Blank, PhD. Presentation includes discussion of wireless industry's "assault on science."

EXHIBIT 35 (FD):
Interview of Dr. Martin Blank concerning the dangers of cell phone use and of radiofrequency radiation in general. Dr. Blank discusses the *BioInitiative Report*, beginning at 23:40.

EXHIBIT 36A (FD): *EMF Research Studies*. Partial list of studies compiled by Dr. Stephen Sinatra, M.D., F.A.C.C., F.A.C.N., C.B.T. which demonstrate a nexus between EMF and adverse health effects and/or non-thermal effects which may lead to health problems. The studies are listed, with accompanying links, according to the following categories:

General
Cancer – Studies Linking Exposure to RF Energy to Development of Tumors
Genotoxcity – Studies Linking Exposure to RF Emissions and Effects on DNA
Cellular Stress Response – Studies Linking Exposure to RF Emissions to Production of Stress Proteins
Cardiovascular Effects – Studies Linking Exposure to RF Emissions to Heart Disturbances
Brain Effects – General
Brain Effects – Studies Linking Blood Brain Barrier and Nerve Effects to Exposure to RF Emissions
Immune Response – Studies Linking Exposure to RF Emissions and Immune Reactions

EXHIBIT 37 (FD):
Reported Biological Effects from Radiofrequency Radiation at Low-Intensity. Series of *BioInitiative Report* color charts which summarize a number of biomedical research studies showing biological effects of *low-intensity* exposures to radiofrequency radiation at levels *below* FCC, ANSI and IEEE safety standards.

The charts are color-coded according to categories of the following biological effects:

Brain tumors and blood-brain barrier effects;
Cancer (other than brain) and cell proliferation;
Cardiac, heart muscle, blood pressure, and vascular effects;
Disrupted calcium metabolism;

Oxidative damage, DNA damage and DNA repair failure;
Reproduction / fertility effects;
Sleep, neuron firing rate, EEG, memory, learning, and behavior;
Stress proteins, disrupted immune function.

Power densities in the studies ranged from an extreme low of 100 femtowatts (10^{-13} microwatts) per square centimeter to 500 microwatts per square centimeter. The safety standard set by the FCC and ANSI/IEEE as the limit for uncontrolled public exposure to 800-900 MHz RF is 530-600 microwatts per square centimeter, and the PCS standard limit for public exposure is 1000 microwatts per square centimeter.

Exposure levels in other studies listed in the charts are expressed in terms of specific absorption rate (SAR) with levels ranging from .000064 W/Kg to 2 W/Kg. The IEEE safety standard for whole body exposure in an uncontrolled public environment is 0.08 W/Kg. The FCC and IEEE SAR limit for 1 gram of tissue in a partial body exposure is 1.6 W/Kg, and the ICNIRP SAR limit for 10 grams of tissue is 2 W/Kg. A substantial number of these studies show biological effects at levels *well below the lowest of these standards*, that is, below 0.08 W/Kg.

The Pennsylvania Public Utility Commission's *Smart Meter Q&A* fact sheet (**EXHIBIT 28**) indicates the radiofrequency power density of a smart meter as being "0.00037 milliwatt per square centimeter." In terms of microwatts, this value converts to 0.37 microwatt per square centimeter. This RF power density ***average*** value ***exceeds*** the power density values specified in eighteen (18) of the studies listed in **EXHIBIT 37** that show biological effects of exposure to RF radiation.

Additionally, the "0.00037 milliwatt per square centimeter" value is an ***average*** value which is calculated on the basis of a 30-minute period. Because smart meters typically emit RF radiation in frequent, high-intensity bursts, the *maximum peak* power densities of these bursts can far exceed the *average* level indicated by the numerical figure given in the *Smart Meter Q&A* fact sheet. Furthermore, the fact sheet fails to specify the ***distance*** from the meter according to which the specified power density was determined.

EXHIBIT 39A (FD):
Research on neurological effects of radiofrequency radiation (2007-2017). Literature selected from the BioInitiative Report. It consists of a review of 325 research papers. Of that total, 235 (78%) showed an observed neurological effect. In 90 (28%) of the studies, no significant neurological effect was observed.

EXHIBIT 39B (FD):
Graphic, based upon research studies presented in **EXHIBIT 39A**, of *Percent Comparison Showing Effect vs No Effect in Neurological Effect Studies*.

EXHIBIT 40 (FD):
Radiofrequency Radiation (RFR) **Comet Assay** (2017.) (BioInitiative Report Research Summaries) Comparative results of research using *Comet Assay* to study DNA damage as a possible effect of electromagnetic field exposure. Of a total of 76 radiofrequency radiation (RFR) studies using *comet assay*, 49 (64%) reported a positive effect, compared to 27 (36%) of the studies which reported no significant effect.

EXHIBIT 41 (FD):
Genotoxicity: *Graphic of Percent Comparison Showing Effect vs. No Effect in Comet Assay and Oxidative Effect Studies* (2017.) (BioInitiative Report Research Summaries) Of a total of 200 studies of RFR-mediated oxidative effects, 180 (90%) reported a positive effect, and 20 (10%) reported no significant effect.

EXHIBITS 42A-1 through 42I (FD):
The ***BioInitiative Report***, updated through 2017. It constitutes an encyclopedic compendium of the available research literature on biological and health effects of exposures to radiofrequency radiation and electromagnetic fields. As of 2015, the entire ***BioInitiative Report*** includes expert analyses of more than 5000 peer-reviewed biomedical research papers assessing experimental methodologies used and strength of evidence obtained.

EXHIBIT 42A-1 (FD):
Biological Effects of Radiofrequency Radiation (RFR) Research Summaries (1990-2017) compiled by Dr. Henry Lai, PhD, University of Washington Department of Bioengineering.

EXHIBIT 42H (FD):
Studies Showing Adverse Biological Effects of Radiofrequency Radiation at Low Intensities. Compiled by Dr. Henry Lai, PhD, University of Washington Department of Bioengineering.

EXHIBIT 42B-1 (FD):
BioInitiative 2012: A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation. The *BioInitiative 2012 Report* has been prepared by 29 authors from ten countries, ten holding medical degrees (MDs), 21 PhDs, and three MSc, MA or MPHs. Among the authors are three former presidents of the Bioelectromagnetics Society, and five full members of BEMS. http://www.bioinitiative.info/bioInitiativeReport2012.pdf

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This document summarizes the massive amount of research evidence pertaining to adverse effects of exposure to electromagnetic field radiation upon human health. This information is broadly organized into the following categories:

A. Evidence for Damage to Sperm and Reproduction
B. **Evidence that Children are More Vulnerable**
C. **Evidence for Fetal and Neonatal Effects**
D. Evidence for Effects on Autism (Autism Spectrum Conditions)
E. **Evidence for Electrohypersensitivity**
F. Evidence for Effects from Cell Tower-Level RFR Exposures
G. **Evidence for Effects on the Blood-brain Barrier**
H. **Evidence for Effects on Brain Tumors**
I. **Evidence for Effects on Genes (Genotoxicity)**
J. **Evidence for Effects on the Nervous System (Neurotoxicity)**
K. **Evidence for Effects on Cancer (Childhood Leukemia, Adult Cancers)**
L. Melatonin, Breast Cancer and Alzheimer's Disease
M. Stress, Stress Proteins and DNA as a Fractal Antenna
N. Effects of Weak-Field Interactions on Non-Linear Biological Oscillators and Synchronized Neural Activity

Section 4 of this document, entitled ***Evidence for Inadequacy of the Standards***, reads in part:

[Inadequacy of standards - Begin quote]

US Government Radiofrequency Interagency Working Group Guidelines Statement

The United States Radiofrequency Interagency Working Group (RFIAWG) cited concerns about current federal standards for public exposure to radiofrequency radiation in 1999 (Lotz, 1999 for the Radiofrequency Interagency Working Group)

"*Studies continue to be published describing biological responses to nonthermal ELF-modulated RF radiation exposures that are not produced by CW (unmodulated) radiation. These studies have resulted in concern that 'exposure guidelines based on thermal effects, and using information and concepts (time-averaged dosimetry, uncertainty factors) that mask any differences between intensity-modulated RF radiation exposure and CW exposure, do not directly address public exposures, and therefore may not adequately protect the public."* (Emphasis added.)

The United States government Federal Radiofrequency Interagency Working Group has reviewed the existing ANSI/IEEE RF thermal-based exposure standard upon which the FCC limit is based. **This Working Group was made up of representatives from the US government's National Institute for Occupational Safety and Health (NIOSH), the Federal Communications Commission (FCC), Occupational Health and Safety Administration (OSHA), the Environmental**

Protection Agency (US EPA), the National Telecommunication and Information Administration, and the US Food and Drug Administration (FDA). (Emphasis added.)

On June 17, 1999, the RFIAWG issued a Guidelines Statement that concluded the present RF standard "may not adequately protect the public". The RFIAWG identified fourteen (14) issues that they believe are needed in the planned revisions of ANSI/IEEE RF exposure guidelines including **"**to provide a strong and credible rationale to support RF exposure guidelines". In particular, **the RFIAWG criticized the existing standards as not taking into account chronic, as opposed to acute exposures, modulated or pulsed radiation (digital or pulsed RF is proposed at this site), time-averaged measurements that may erase the unique characteristics of an intensity-modulated RF radiation that may be responsible for reported biologic effects, and stated the need for a comprehensive review of long-term, low-level exposure studies, neurological-behavioral effects and micronucleus assay studies (showing genetic damage from low-level RF)**. (Underlining and emphasis added.)

The existing federal standards may not be protective of public health in critical areas. The areas of improvement where changes are needed include: a) selection of an adverse effect level for chronic exposures not based on tissue heating and considering modulation effects; b) recognition of different safety criteria for acute and chronic exposures at nonthermal or low-intensity levels; c) recognition of deficiencies in using time-averaged measurements of RF that does not differentiate between intensity-modulated RF and continuous wave (CW) exposure, and *therefore may not adequately protect the public.*

[Inadequacy of standards - End quote]

EXHIBIT 42I (FD):

BioInitiative Report Summary for the Public (2014 Supplement) and Summary of Key Scientific Evidence.

EXHIBIT 42B-2 (FD):

BioInitiative Report 2012 Conclusions. Brief outline of scientific evidence and fundamental principles justifying major revisions in current RFR safety standards which should be adopted and incorporated by all government agencies into their public health policies.

EXHIBIT 42E (FD):
BioInitiative 2007 Report - Summary for the Public, Summary of the Science, and Conclusions.

A. Evidence for Cancer (Childhood Leukemia and Adult Cancers)
B. Changes in the Nervous System and Brain Function
C. Effect on Genes (DNA)
D. Effects on Stress Proteins (Heat Shock Proteins)
E. Effects on the Immune System
F. Plausible Biological Mechanisms

Pages 5 and 6 read in part:

"Today's public exposure limits for telecommunications are based on the ***presumption*** that heating of tissue (for RF) or induced electric currents in the body (for ELF) are the only concerns when living organisms are exposed to RF." ...

"In the last few decades, it has been established **beyond any reasonable doubt** that bioeffects and some adverse health effects occur at far lower levels of RF and ELF exposure where no heating (or induced currents) occurs at all; **some effects are shown to occur at several hundred thousand times below the existing public safety limits where heating is an impossibility**.

"Effects occur at non-thermal or low-intensity exposure levels thousands of times below the levels that federal agencies say should keep the public safe. For many new devices operating with wireless technologies, the devices are exempt from any regulatory standards. The existing standards have been ***proven to be inadequate to control against harm from low-intensity, chronic exposures***, based on any reasonable, independent assessment of the scientific literature." ...

"Recent opinions by experts have documented deficiencies in current exposure standards. There is widespread discussion that thermal limits are outdated, and that biologically-based exposure standards are needed. Section 4 describes concerns expressed by WHO, 2007 in its ELF Health Criteria Monograph; the SCENIHR Report, 2006 prepared for the European Commission; the UK SAGE Report, 2007; the Health Protection Agency, United Kingdom in 2005; the NATO Advanced Research Workshop in 2005; the US Radiofrequency Interagency Working Group in 1999; the US Food and Drug Administration in 2000 and 2007; the World Health Organization in 2002; the International Agency for Cancer Research (IARC, 2001), the United Kingdom Parliament Independent Expert Group Report on Mobile Phones – Stewart Report, 2000) and others." (Underlining, italics and emphasis added.)

EXHIBIT 42G (FD):

BioInitiative Report 2007: *A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*. This report consists of analyses and reviews by scientists of the scientific evidence for various biological effects of exposure to radiofrequency radiation and electromagnetic fields. It very strongly supports the propositions that these effects do occur at levels of exposure well below government safety guidelines and that the currently accepted standards are insufficient for the protection of public health and safety. The report is organized according to the following sections:

SECTION 1: Summary for the Public and Conclusions
Ms. Cindy Sage, MA

SECTION 2: Statement of the Problem
Ms. Cindy Sage, MA

SECTION 3: The Existing Public Exposure Standards
Ms. Cindy Sage, MA

SECTION 4: Evidence for **Inadequacy of the Standards**
Ms. Cindy Sage, MA

SECTION 5: **Evidence for Effects on Gene and Protein Expression**
Dr. Zhengping Xu, PhD and Dr. Guangdi Chen, PhD

SECTION 6: **Evidence for Genotoxic Effects - RFR and ELF Damage**
Dr. Henry Lai, PhD

SECTION 7: **Evidence for Stress Response (Stress Proteins)**
Dr. Martin Blank, PhD

SECTION 8: **Evidence for Effects on Immune Function**
Dr. Olle Johansson, PhD

SECTION 9: **Evidence for Effects on Neurology and Behavior**
Dr. Henry Lai, PhD

SECTION 10: **Evidence for Brain Tumors and Acoustic Neuromas**
Dr. Lennart Hardell, MD, PhD, Dr. Kjell Hansson Mild, PhD, and Dr. Michael Kundi, PhD

SECTION 11: **Evidence for Childhood Cancers (Leukemia)**
Dr. Michael Kundi, PhD

SECTION 12: Magnetic Field Exposure: Melatonin Production; Alzheimer's Disease; Breast Cancer Dr. Zoreh Davanipour, DVM, PhD, and Dr. Eugene L. Sobel, PhD

SECTION 13: **Evidence for Breast Cancer Promotion**
Ms. Cindy Sage, MA

SECTION 14: **Evidence for Disruption by the Modulating Signal**
Dr. Carl F. Blackman, PhD

SECTION 15: Evidence Based on EMF Medical Therapeutics
Ms. Cindy Sage, MA

SECTION 16: The Precautionary Principle

Table 1-1, BioInitiative Report Overall Conclusions (pages 44 and 45) reads in part:

[Exhibit 42G - Signal modulation - Begin quote]

Section 14. Effects of Modulation of Signal

• There is substantial scientific evidence that some modulated fields (pulsed or repeated signals) are bioactive, which increases the likelihood that they could have health impacts with chronic exposure even at very low exposure levels.

• Modulation signals may interfere with normal, non-linear biological processes.

• Modulation is a fundamental factor that should be taken into account in new public safety standards; at present it is not even a contributing factor [in present standards].

• To properly evaluate the biological and health impacts of exposure to modulated RF (carrier waves), it is also essential to study the impact of the modulating signal (lower frequency fields or ELF-modulated RF).

• **Current standards have ignored modulation as a factor in human health impacts, and thus are inadequate in the protection of the public in terms of chronic exposure to some forms of ELF-modulated RF signals.** (Underlining and emphasis added.)

• **The current IEEE and ICNIRP standards are not sufficiently protective of public health with respect to chronic exposure to modulated fields (particularly new technologies that are pulse-modulated** and heavily used in cellular telephony). (Underlining and emphasis added.)

• **The collective papers on modulation appear to be omitted from consideration in the recent WHO and IEEE science reviews. This body of research has been ignored by current standard setting bodies that rely only on traditional energy-based (thermal) concepts**. (Underlining and emphasis added.)

• More research is needed to determine which modulation factors, and combinations are bioactive and deleterious at low intensities, and are likely to result

in disease-related processes and/or health risks; however this should not delay preventative actions supporting public health and wellness.

• If signals need to be modulated in the development of new wireless technologies, for example, it makes sense to use what existing scientific information is available to avoid the most obviously deleterious exposure parameters and select others that may be less likely to interfere with normal biological processes in life.

• The current membership on Risk Assessment committees needs to be made more inclusive, by adding scientists experienced with the research reporting non-thermal biological effects.

• The current practice of segregating scientific investigations (and resulting public health limits) by artificial divisions of frequency needs to be changed because **this approach dramatically dilutes the impact of the basic science results and eliminates consideration of modulation signals, thereby reducing and distorting the weight of evidence in any evaluation process**." (Emphasis added.)

[Exhibit 42G - Signal modulation - End quote]

EXHIBITS 43A through 43G (FD):
Biological and Health Effects of Microwave Radiofrequency Transmissions: A Review of the Research Literature. Paul Dart, M.D., FCA, Kathleen Cordes, M.D., Andrew Elliott, N.D., James Knackstedt, M.D., Joseph Morgan, M.D., Pamela Wible, M.D., Steven Baker, Technical Advisor. A thorough and well-researched review of current medical literature on the non-thermal, biological effects of exposure to radiofrequency radiation. A review of the research literature and specific areas of focus are presented in:

EXHIBIT 43A. A Review of the Research Literature
EXHIBIT 43B. Health Effects of Microwave Radio Exposures: Acute Symptoms from RF Exposure: 'EHS'
EXHIBIT 43C. Consequences of Chronic Microwave RF Exposure
EXHIBIT 43D. Effects of Microwave RF Exposure on Fertility
EXHIBIT 43E. Alterations in Hormone Physiology
EXHIBIT 43F. Microwave RF Interacts with Molecular Structures
EXHIBIT 43G. Cell Phones and Risk of Brain Tumor

EXHIBITS 44A through 44N (FD):
Additional biomedical research and related information including *The Seletun Report* and *Statements of Concern from Scientists, Physicians, Health Policy Experts & Others*.

EXHIBIT 44E-2 (FD):
The Seletun Declaration. Dr. Olle Johansson, PhD, Associate Professor and Head of Experimental Dermatology, Department of Neuroscience, Karolinska Institute, Stockholm, Sweden, Professor, Royal Institute of Technology, and world-leading authority on EMF radiation and health effects. Statements beginning at 02:05 :

"Low-intensity (non-thermal) bioeffects and adverse health effects are demonstrated at levels significantly below existing exposure standards for telecommunications and power utility technologies. **ICNIRP and IEEE/FCC public safety limits are inadequate and obsolete with respect to prolonged, low-intensity exposures common today**. It is not in the public interest to wait. Instead, governments should take decisive action now to protect biological function as well as the health of future generations."

EXHIBIT 44J (FD):
Health Effects of Electromagnetic Fields: Modern Wireless Telecommunications. Dr. Olle Johansson, PhD. Dr. Johansson discusses genotoxicity and DNA damage effects of exposure to radiofrequency radiation, beginning at 46:36. He illustrates these effects visually using ***comet assay*** results, beginning at 47:38. The photographs appear to show comparable amounts of DNA fragmentation damage between damage that was due to a 24-hour exposure to mobile phone radiation at a specific absorption rate (SAR) of 1.3 W/Kg, and damage that was sustained from exposure to a radiation dosage equivalent of 1600 chest x-rays. The specific absorption rate in the assay was significantly less than the ICNIRP/WHO safety guideline of 2 W/Kg. (*The wireless telecommunications industry tried for two years to stop publication of this study.*) A chart is displayed, beginning at 50:13, that shows results of multiple studies from as early as 1995 which demonstrated adverse health effects at radiofrequency exposure levels far below the ICNIRP/WHO safety guidelines. One such study showed adverse cellular effects from exposure to a 960 MHz GSM cell phone signal at a specific absorption rate that was *more than 100,000 times less* than the ICNIRP/WHO safety guidelines.

EXHIBIT 44K (FD):
Electromagnetic Fields and DNA Damage. Dr. Jerry Phillips, PhD, Research Biochemist and Professor of Chemistry, University of Colorado. The issue of

'contrary data' is discussed, beginning at 1:07. Dr. Phillips directly addresses the meaning and proper use of '***weight of evidence***', beginning at 15:05 minute-mark.

EXHIBIT 44L-1 (FD):
Congressional Staff Briefing. *Electromagnetic Fields: The Science on Human Health Effects*. Dr. Ted Litovitz, PhD, EMR Researcher and Professor Emeritus of Physics, Director of the BioElectromagnetics Laboratory, Catholic University of America. This briefing was later entered into the official court record in the HDTV broadcast antenna siting case for Lookout Mountain, Colorado. The briefing affirms that weak electromagnetic fields can induce non-thermal biological effects. Dr. Litovitz displays image result of ***comet assay*** at 10:46 minute-mark. (See also **EXHIBIT 44L-2**.)

Partial transcript (underlining and emphasis added):

"Today, in the bioelectromagnetic field, if something's not replicated, the answer is: the people who got an effect are incompetent—standard answer. Those who see nothing are competent. Science is divided down the middle. You...are competent because you don't see a thing.

"There is a genetic basis for lack of replication. **You don't simply say that the effect is not there if every lab can't replicate it**.

"But what we've discovered, and not in just my lab, is that there's information sent to a cell—**information which is a signal which turns the cell on and causes it to do something it wouldn't normally do**. **You don't have to heat it to stimulate it with an electromagnetic field**.

"Just in June [2001], two statements were made that are crucial. For the first time, an international agency [IARC] has stated: 'Power frequency magnetic fields are possible carcinogens.' **That's a strong statement**—The word 'possible'. It's very strong because EPA tried to make it for years but was never allowed to. ... **This statement is based upon research** which was just published four months ago **in which ten labs got together on all the ten epidemiologic studies, which included a study by NIH** ... ."
...
"How can non-ionizing radiation increase the probability of cancer? [@ 18:13 minute-mark] This is a just a beautiful graph which was worked by researchers at NRC and NIH." [display of graph: "The Antimutagenic DNA Damage-Control Biosystem"]
...

"You're being bombarded by these reactive oxygen species; you're being bombarded by stimuli which tend to break DNA. ... Anything which diminishes the protective mechanism is a problem. Electromagnetic radiation diminishes [cancer] protection because it lowers melatonin, which is an antioxidant, and it also lowers these stress proteins which are also antioxidants. **Electromagnetic radiation will also diminish repair—if it's on every day—it diminishes the ability to repair**. **And** finally, **it diminishes the immune response which protects you from any tumor that does tend to form.**

"**What's the effect of reducing your protective mechanism? You will have a higher probability of mutations** ... . The point is, slight fiddling of your defense mechanism enhances the number of broken DNAs. This enhances the probability of cancer. ...

"Every day, if you continue to use a cell phone, you continue to accumulate these broken DNAs.

"The basic defect that we see in all cancer has to do with DNA damage, and **it's been shown unequivocally in the hundreds, hundreds of studies that the same radiation that comes off those towers causes DNA damage. And when DNA is damaged, you can lose control of cell growth, and that causes cancer, and that is a scientific fact.**

"And for someone to sit there and say: 'Don't worry about it. This has no effect.' It's absolutely ludicrous."

Dr. Litovitz concludes the briefing with the following commentary: "If ... the government is going to preempt (property), ... it has the responsibility to know what it's doing to those who are around that preempted sight, *and preemption should not come before it fulfills its responsibility to understand what the effect of that site will cause*."

EXHIBIT 45C-1 (FD):
Guidelines, exposures and effects of radio frequency radiation at various power densities. Graphic indicating adverse health effects at exposures to radiofrequency radiation levels many orders of magnitude below FCC safety guidelines. (See also **EXHIBIT 45C** for related facts and details.)

EXHIBIT 45M (FD):
Letter, dated December, 2015, from Dr. Olle Johansson, PhD, Karolinska Institutet Department of Neuroscience, to Montgomery County Public Schools. Reads in part:

"[E]xposure to electromagnetic fields not only may induce acute thermal effects to living organisms, but also **non-thermal effects**, the latter often after longer exposures. This has been **demonstrated** in a very large number of **non-ionizing radiation** studies and includes cellular DNA-damage, disruptions and alterations of cellular functions like increases in intracellular stimulatory pathways and calcium handling, disruption of tissue structures like the blood-brain barrier, impact on vessel and immune functions, and loss of fertility. Whereas scientists can observe and reproduce these effects in controlled laboratory experiments, epidemiological and ecological data derived from long-term exposures in well-designed case-control studies reflect this link all the way from molecular and cellular effects to the living organism up to the induction and proliferation of diseases observed in humans."

...

"I was also the first person to firmly point out that this involuntary exposure violates the Nuremberg Code's principles for human experimentation ... ."

...

"[T]oday's recommended values for wireless systems, such as the SAR-values, **are just recommendations, and not safety levels**. Since scientists observe biological effects at as low as 20 microWatts/kg, can it truly be stated that it is safe to allow irradiation of humans at SAR 2 W/kg, or at 100,000 times stronger levels of radiation?"

...

"Another misunderstanding is the use of scientific publications (as the tobacco industry did for many years) as 'weights' to balance each other. But **one can NEVER balance a report showing a negative health effect with one showing no effect**. This is a misunderstanding which, unfortunately, is very often used both by the industrial representatives as well as official authorities to the detriment of the general public. **True balance would be reports showing negative health effects against *exact replications* showing no or positive effects**."

...

"I encourage governments and local health and educational bodies to adopt a framework of guidelines for public and occupational EMF exposure that reflect the **Precautionary Principle**. As noted, the Precautionary Principle states when there are indications of possible adverse effects, though they remain uncertain, **the risks from doing nothing may be far greater than the risks of taking action to control these exposures**. The Precautionary Principle shifts the burden of proof from those suspecting a risk to those who discount it ... ." (Underlining and emphasis added.)

EXHIBIT 45N (FD):
Letter, dated November 30, 2015, from Dr. Lennart Hardell, MD, PhD, and Michael Carlberg, Department of Oncology, Orebro University Hospital, Sweden, to Montgomery County Public Schools. Reads in part:

"Wireless ... infrastructure and wireless devices ... should be avoided for these reasons:

- "Wireless radiofrequency radiation emissions were classified as a Possible Human Carcinogen (group 2B) by the World Health Organization International Agency for Research on Cancer (IARC) in May 2011. ... Dr. Hardell, was part of the evaluation group.

- **The IARC classification holds for *all forms of radio frequency radiation* including RF-EMF emissions from wireless transmitters** ... .

- **Epidemiological studies show links between radiofrequency radiation (RFR) exposure and cancers, neurological disorders, hormonal changes, symptoms of electrical hypersensitivity (EHS) and more. Laboratory studies show that RFR exposure increases risk of cancer, abnormal sperm, learning and memory deficits, and heart irregularities. Foetal exposures in both animal and human studies may result in altered development in the young offspring, with disruption in learning, memory and behaviour**.

- **The research showing increased brain cancer risk has *strengthened* since the IARC 2011 classification as new research has been published which repeatedly shows a significant association after RF exposure**. **In addition, tumour promotion studies have now been replicated showing cancer promotion after exposures at low levels**. Therefore, **it is our opinion and that of many colleagues that the current IARC cancer risk classification should move to an *even higher* risk group**.

"**The evidence for these statements is based on hundreds of published, peer-reviewed scientific studies that report adverse health effects as levels much lower than current ICNIRP and FCC public safety limits. Compliance with government regulations does not mean that ... wireless environment is safe** ... .

"As researchers in cancer epidemiology and radio frequency radiation exposures, we have published extensively in this area ... . **Multiple epidemiological research studies show that exposures equivalent to 30 minutes a day of cell phone use over ten years results in significantly increased brain cancer risk** ... .

"... Wireless networks ... results in full body low level RF-EMF exposures that can have a cumulative effect on the developing body of a child. **No safe level of this radiation has been determined by any health agency and therefore we have no safety assurances**. Cancers can have long latency periods (time from first exposure until diagnosis) and it will take decades before we know the full extent of health impacts from this radiation. The statistics and effects will be borne by the children you serve.

"Wi-Fi ... will increase risk of neurologic impairment and long-term risk of cancer ... . Promoting wireless technology ... disregards the current health warnings from international science and public health experts in this field." (Underlining and emphasis added.)

EXHIBIT 45O (FD):
Letter, dated November 29, 2015, from Dr. David O. Carpenter, MD, Director, Institute for Health and the Environment, University at Albany, State University of New York, to Montgomery County Public Schools. Reads in part:

"**There is strong and consistent evidence that excessive exposure to radiofrequency electromagnetic fields has adverse human health effects**. Of particular concern is the clear evidence that children are more vulnerable than adults. The **best documented adverse effects are an increase in risk of cancer after years of exposure as evidenced by the results of the Interphone, Hardell and French CERENAT studies. These research studies found increased cancer risk in the "heavy" users of cell phones after ten years of use. However, 'heaviest use' corresponded to the equivalent of *just* thirty minutes a day in these research studies**. Please note that cancers do not appear immediately upon exposure but rather come years later.
...
"The exposure levels of the Federal Communications Commission are totally outdated and do not protect the health of the public, especially of children."

EXHIBIT 45P (FD):
Letter, including *More Detailed Summary of the Pathophysiology* and *Citations*, dated December, 2015, from Dr. Martha Herbert, PhD, MD, Neurologist, Harvard Medical School, to Montgomery County Public Schools. Reads in part:

"**EMF can certainly contribute to degrading the physiological integrity of the system at the cellular and molecular level** – **and this in turn appears to contribute to the pathogenesis/causation** not only of autism but **of many highly common chronic illnesses, including cancer**, obesity, diabetes **and heart disease**.

"**In fact, there are thousands of papers that have accumulated over decades – and are now accumulating at an accelerating pace, as our ability to measure impacts become more sensitive – that document adverse health and neurological impacts of EMF/RFR**. **Children are more vulnerable** than adults, and **children with chronic illnesses and/or neurodevelopmental disabilities are even more vulnerable**. **Elderly or chronically ill adults are more vulnerable** than healthy adults.

"Current technologies were designed and promulgated without taking account of biological impacts other than thermal impacts. **We now know that there are a large array of impacts that have nothing to do with the heating of tissue**. **The claim from wifi proponents that the only concern is thermal impacts is now definitively outdated scientifically**.

"Radiofrequency electromagnetic radiation from wifi and cell towers can exert a disorganizing effect on the ability to learn and remember, and can also be destabilizing to immune and metabolic function. This will make it harder for some children to learn, particularly those who are already having learning or medical problems in the first place. And **since half of the children in this country have some kind of chronic illness, this means that a lot of people are more vulnerable than you might expect to these issues**.

"Powerful industrial entities have a vested interest in leading the public to believe that EMF/RFR, which we cannot see, taste or touch, is harmless, but this is not true."

EXHIBIT 45Q (FD):
Letter, including references, dated December, 2015, from Mikko Ahonen, PhD, Research Manager, Finland Institute of Environmental Health and Safety, Lena Hedendahl, MD, Luleå, Sweden, and Tarmo Koppel, MSc, PhD Candidate, Tallin University of Technology, Estonia, to Montgomery County Public Schools. Reads in part:

"In cell phone technologies (like GSM) the difference between average and peak value is 2-fold. **In Wireless local area technologies like Wi-Fi, the difference between average value and peak value is up to 100-fold** (Ferro & Potorti, 2005). ..."
...
"The MCPS has not provided **information about Wi-Fi technology, namely it's beacon signal**. This signal, officially **SSID (Service Set IDentifier), is created by the access point (AP) by sending constantly SSID 10 times in a second , at 10 Hz** (Ferro and Poporti, 2005). **Mobile industry has patented technology to avoid**

this constant SSID sending for health reasons (Swisscom, 2004). This SSID sending at 10 Hz is an additional risk-factor and it should be mentioned. Our brain operates in alpha, beta and gamma bands. This Wi-Fi beacon overlaps the alpha band. Low-frequency EMFs (including low-frequency pulses) have an effect on evoked potentials of the brain (Carrubba *et al.,* 2008).

"**Because of the risk of this 10 Hz Beacon signal of Wi-Fi, The European Academy for Environmental Medicine has assigned very strict precautionary RF-levels for Wi-Fi** (Belyaev et al., 2015). ..."
...
"**We would like to draw attention to** long-term exposure related health risks.

"Radiofrequency radiation from Wi-Fi devices causes fertility problems as shown by several in vivo and in vitro studies (see for example Atasoy *et al.*, 2013, Avendaño *et al*,. 2012, Dasdag *et al.*, 2015a, Shokri *et al*., 2015).

"Additionally, **RF-radiation from Wi-Fi access points (AP) causes oxidative stress in cells which leads to several disorders** (see for example Nazıroğlu *et al*., 2012, Aynali *et al.,* 2013, Salah *et al.*, 2013). The overall detrimental impact of RF radiation induced oxidative stress is summarised in the review of Yakymenko *et al.* (2015).

"**Regarding: The IARC classification of RF-EMF as Group 2B, i.e., 'possibly' carcinogenic to humans and the MCPS Report's inaccurate interpretation**

"The classification of radiofrequency electromagnetic fields (RF-EMF) as Group 2B, i.e., 'possibly' carcinogenic to humans,was made by 30 scientists from 14 countries at a meeting 2011 for the International Agency for Research on Cancer (IARC), World Health Organization (IARC 2011, Baan et al. 2012). **The working group mainly based their classification on one cohort study** (Schüz et al., 2006) **and five case-control studies** (Muscat et al., 2000, Inskip et al., 2001, Auvinen et al.,2002, The Interphone study group, 2010, Hardell et al., 2011).

"**They also reviewed more than 40 studies that assessed the carcinogenicity of RFEMF in rodents, including seven 2-year cancer bioassays and also many studies with endpoints relevant to mechanisms of carcinogenesis, including genotoxicity, effects on immune function, gene and protein expression, cell signaling, oxidative stress, and apoptosis** (Baan et al., 2011).

"The referred INTERPHONE study (The Interphone study group, 2010), in the MCPS radiation report, was one of the case-control studies. **The Interphone study was a multicentre study of mobile phone use and brain tumours, including malignant tumours in the brain as glioma and benign tumours as acoustic**

neuroma and meningioma. The pooled analysis included 2708 glioma cases and 2972 controls
(participation rates 64% and 53%, respectively). In the Interphone study a regular user of mobile phones had an average of at least one call per week for a period of ≥6 months. **This very low user group was compared to several other groups of low users compared to nowadays more extensive use of mobile phones.** The highest group of users, ≥1640 hours was divided in three sub groups depending on how many years they had used a mobile phone. For the shortest time span on 1-4 years only 23 of the glioma cases and 8 of the controls had used their mobile phones for more than 1640 hours. If any of these 23 persons with a brain cancer or any of the 8 controls had used their mobile phones for only one year they would have used it at least in average for four and a half hours a day during a year. If they instead had talked in their mobile phones during four years it would be for an average of a little more than an hour a day.

"For the group of users between 5 and 9 years, 84 cases and 73 controls, the use per day would be at least between 54 minutes and 30 minutes. **For the long user group of 10 years or more, 93 cases and 73 controls, they talked in their mobile phones for 27 minutes a day or less for more than 10 years of use.**

"For the main part of cases their use of mobile phones had been for a lot less than four hours a day. Today when most people use only their mobile phone and landline phones both at home and at work are becoming scarce, an amount of 4 hours or more wireless telephone use / day for salesman, telephone operators and so on is not uncommon. **In the Interphone study there was an statistical significant increased risk for a malignant brain tumour of 1.4 times (odds ratio, OR, 1.4, 95% CI 1.03-1.89) only for the highest user group of a total on more than 1640 hours**. (Underlining and emphasis added.)

"Hardell et al. (2011) in Sweden found that **cases who had used a mobile phone for more than 1 year had an increased risk for glioma of 1.3** (OR 1.3, 95% CI 1.1-1.6). The **risk increased with increasing time since first use and with total call time, reaching 3.2 times** (OR 3.2, CI 2.0-5.1) **for more than 2000 hours of use**. Use of the mobile phone on the same side of the head as the tumour was associated with higher risk.

"**Since 2011 several other studies have been published which are strengthening the possible association between RF-EMF and cancer.** Using the **Bradford Hill viewpoints for evaluating strengths of evidence of the risk for brain tumours associated with use of mobile and cordless phones the classification should be upgraded to group 1 carcinogen, i.e., 'the agent is carcinogenic to humans'** (Hardell & Carlberg, 2013).

"**New case-control studies have verified Hardell's studies (Coureau et al., 2014) and up to 20 years of mobile phone use have found even higher risk for brain tumours** (Hardell & Carlberg, 2015). (Underlining added.)

"A newly published study has found a tumor promotion effect on mice from exposure to radiofrequency electromagnetic fields below exposure limits for humans (Lerchl *et al*., 2015). ... **[N]umerous studies have shown generation of reactive oxygen species (ROS) that can cause oxidative damage of DNA. This is a well-known mechanism in carcinogenesis for many agents.** The broad biological potential of ROS and other free radicals makes radiofrequency radiation a potentially hazardous factor for human health, not only cancer risk but also other health effects (Yakymenko *et al*., 2015). (Underlining added.)

"**The IARC classification of RF-EMF as Group 2B, possibly carcinogenic to humans,** doesn't only include exposure from mobile phones near the ear. **The classification includes all sources of RF-EMFs.** The exposure from mobile phone base stations, Wi-Fi access points, smart phones, laptops and tablets can be long term, sometimes around the clock both at home and at school. **This constant exposure to lower levels of exposure may be as deleterious to health as higher exposure during short time** (Fragopoulou et al., 2012, Dasdag et al., 2015b). This **risk may be accentuated for children because their probable longer use of wireless devices** (Morgan et al., 2014). **Children are also growing and have more immature cells which can be more sensible to RF-EMF** (Markova et al., 2010)" (Underlining added.)

EXHIBIT 45R-1 (FD):
Letter, dated December, 2015, from Dr. Anthony B. Miller, MD, Professor Emeritus at the Dalla Lana School of Public Health, University of Toronto, to Montgomery County Public Schools. Reads in part:

"I am a physician epidemiologist specializing in cancer etiology, prevention and screening ... . In the past I served as Assistant Executive Director (Epidemiology) of the National Cancer Institute of Canada; Director, Epidemiology Unit, National Cancer Institute of Canada, Toronto, and Chairman, Department of Preventive Medicine and Biostatistics, University of Toronto. I have conducted research on ionizing radiation and electromagnetic fields and cancer. I have served on many expert committees assessing the carcinogenicity of various exposures, including working groups of the World Health Organization's International Agency for Research on Cancer (IARC).

"I am writing to ensure you have accurate information about the research on radiofrequency radiation and health ... .

"In 2011 a working group of IARC classified Radiofrequency radiation as a Class 2B Carcinogen, a possible human carcinogen (May 31, 2011 Press Release by the International Agency for Cancer, Lyon, France). The IARC 2013 Monograph vol. 102 details the evidence that provided the scientific basis for the classification:

- **Epidemiological studies that looked at long term cell phone exposures found an increased risk of brain cancer after** heavy cell phone **exposures equivalent to about 30 minutes a day for over ten years**.

- **The IARC classification is intended to apply *to all radiofrequencies from 0KHz to 300GHz*** clearly including the 2.45 GHz commonly used for wireless networks in schools; specifically wireless laptops, wireless tablets and Wi---Fi access points.

- **Current US exposure guidelines for radiofrequency energy radiation levels were developed three decades ago to avoid heat and they did not consider the unique vulnerability of children to this type of radiation**. **FCC compliance is therefore not proof of safety**.

- **Many studies have shown that RF radiation exposures *at levels that do not induce heat* can damage the nervous system, impair sleep, hearing and reproductive health, and increase the risk of cancer**.

- Children absorb RF radiation deeper into their bodies and brain than adults and they are far more vulnerable than adults to adverse effects of RF radiation now and in the future.

"I recently co-authored a review paper in the International Journal of Oncology, which looked at research published after the 2011 IARC 2B classification. **We concluded that radiofrequency fields should be re---classified as a Group 2A probable human carcinogen under the criteria used by the International Agency for Research on Cancer**.

"It often takes many years between the use of a new cancer-causing agent — such as tobacco — and the observation of an increase in cancer rates. Initially, we thought lung cancer was the only effect of smoking but now we understand a myriad of cancers plus heart disease, stroke, diabetes, rheumatoid arthritis, cataracts, inflammation, impaired immune function and more are caused by cigarette smoke. **Similarly**, **research indicates a far too long list of possible biological effects from radiofrequency exposures *in addition to brain cancer*. Accumulated research indicates oxidative stress, neurological, immune and reproductive damage occurs after exposure to RF radiation.** It will be some years before we see the full effects from this exposure in the population and understand the full extent of its harmful effects."

...
"Waiting for the government to update their decades old regulations will be too late for the children currently being exposed to RF radiation ... ." (Underlining and emphasis added.)

EXHIBIT 45R-2 (FD):
Letter, dated August, 2016, from Dr. Anthony B. Miller, MD, Professor Emeritus at the Dalla Lana School of Public Health, University of Toronto, to Petaluma Public Schools. Reads in part:

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.

"**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, <u>even more with increasing duration of exposure</u>**. 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."
...
"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." (Underlining and emphasis added.)

6. Exhibits and Partial Transcripts of Medical and Scientific Abstracts on Effects and Medical Applications of Exposure to RF

This section includes the following:

Exhibit Nos. 6A, 6B, 6C, 6D, 6E, 6F, 17D, and 34C-2.

All of the exhibits listed within this section constitute directly relevant and highly credible evidence of completely reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

EXHIBITS 6A through 6F (FD):
Experimental research studies using frequencies which are **known to disrupt nerve function** and which are the in lower kHz range as are the high-frequency voltage transients and RF fields produced by the Switch Mode Power Supply (SMPS) of AMI wireless smart meters.

EXHIBIT 6A. ***Conduction block*** *in myelinated axons induced by high-frequency (kHz) non-symmetric biphasic stimulation*
EXHIBIT 6B. *Reversible* ***conduction block*** *in peripheral nerve using electrical waveforms*
EXHIBIT 6C. *Mechanism of nerve* ***conduction block*** *induced by high-frequency biphasic electrical currents* - Abstract (IEEE)
EXHIBIT 6D. *High-frequency electrical* ***conduction block*** *of mammalian peripheral motor nerve* - Abstract
EXHIBIT 6E. *Localized electrical* ***nerve blocking*** - Abstract (IEEE)
EXHIBIT 6F. *Modeling analysis of negative effects of high frequency electrical stimulation on axonal behaviors* - Abstract (IEEE)

EXHIBIT 17D (FD):
Exposure to 900 MHz electromagnetic fields activates the mkp-1/ERK pathway and causes blood-brain barrier damage and cognitive impairment in rats (Abstract). Jun Tang, Yuan Zhang, Liming Yang, Qianwei Chen, Liang Tan, Shilun Zuo, Hua Feng, Zhi Chen, Gang Zhu, Department of Neurosurgery, Southwest Hospital, Third Military Medical University, Chonqing, China.

EXHIBIT 34C-2 (FD):
***Brain proteome response following whole body exposure of mice to mobile phone or wireless DECT base radiation*.** Adamantia F. Fragopoulou, et al. *Electromagnetic Biology and Medicine*, Early Online: 1–25, 2012. (Abstract)

Using ordinary working conditions of mobile phone and wireless DECT base and applying state-of-the-art proteome science, these researchers demonstrated that a large number (143) of major mammalian brain proteins had been dysregulated by exposure to RF radiation. These proteins, which are responsible for the integrity of brain functions in such regions critical to learning and memory as the hippocampus, cerebellum and frontal lobe, were found to be below normal levels, with an equally-large number found to be well above normal physiological levels. These

'under-expressed' or 'over-expressed' proteins may play a role in the short-term or long-term effects reported as consequences of mobile phone exposure, including memory deficits, headaches, sleep disorders, and brain tumors. This study is the first large-scale analysis of the mouse brain proteome to be published.

7. Exhibits and Partial Transcripts of *Microwave News* and Other Bona Fide News Releases on Science Concerning RF

This section includes the following:

Exhibit Nos. 19A-1, 19A-2, 20E, 21A-1, 21A-2, 21A-3, 21B-1, 21B-2, 21B-10, 21B-11, 21B-12, 21B-18, 21C-4, 21C-6, 22B, 24I, 24J, 24K, 24M, 24O, and 29C-16.

All of the exhibits listed within this section constitute directly relevant and highly credible evidence of reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria,* supra.

EXHIBIT 19A-1 (FD):
Cell Phone Radiation Changes Brain Metabolism. Microwave News, February 22, 2011. Reads in part:

[RFR changes brain metabolism - Begin quote]

A well-regarded and influential team of researchers from the National Institutes of Health (NIH) and the Brookhaven National Lab (BNL) is on the brink of resolving a long-standing dispute with enormous implications for public health. ... Nora Volkow and coworkers are **reporting that cell phone radiation *can* affect the normal functioning of the human brain**. (Underlining and emphasis added.)

...[T]he new finding, if confirmed, would at the very least force a rethink of the prevailing orthodoxy, which maintains that low levels of RF and microwave radiation are too weak to have any effect and can be disregarded.

"The study is important because it documents that the human brain is sensitive to the electromagnetic radiation that is emitted by cellphones," Volkow told the *New York Times.*

Using positron emission tomography (PET), the NIH-BNL researchers have shown that radiation from a 50-minute cell phone exposure can speed up glucose metabolism, an established measure of brain activity. The finding is highly

statistically significant. What is particularly remarkable about the new work is that those regions of the brain that were most highly exposed to phone radiation had the largest increases in metabolic activity. The NIH-BNL paper is published in the February 23rd issue of the *Journal of the American Medical Association (JAMA).*

"This paper is just dynamite," said David Carpenter, the director of the Institute for Health and the Environment in Albany, NY. "It's going to be very difficult to deny that RF radiation from a cell phone does not alter nervous system activity." Carpenter, a neurophysiologist, has been active in the electromagnetic research community for over 30 years.

Ronald Herberman, the former director of the University of Pittsburgh Cancer Institute, called the NIH-BNL report "stunning."

The still dominant view among health and safety committees is that if RF and microwave radiation does not cause bulk heating, there will be no biological effects. Yet, the changes in brain metabolism observed by the Volkow group do not appear to have been caused by a temperature rise.

It is unlikely that the changes seen in the brain could result from a thermal effect, Volkow told *Microwave News.* Volkow is the director of the National Institute on Drug Abuse (NIDA), one of the 21 institutes that make up the NIH.

An editorial that accompanies Volkow's paper echoes this conclusion. "[B]rain areas that showed an increase in glucose metabolism were quite distant from the [phone]. Thus, it is not likely that the effects were caused by heating," wrote Henry Lai of the University of Washington, Seattle, and Lennart Hardell of Sweden's Öreboro University Hospital.

"It's time to stop denying the existence of non-thermal effects," Hardell said in an interview.

Lai and Hardell pose what they call "an important question": whether glucose metabolism in the brain might be "chronically increased from the regular use of a wireless phone." Such potential health effects need to be clarified, they stated.

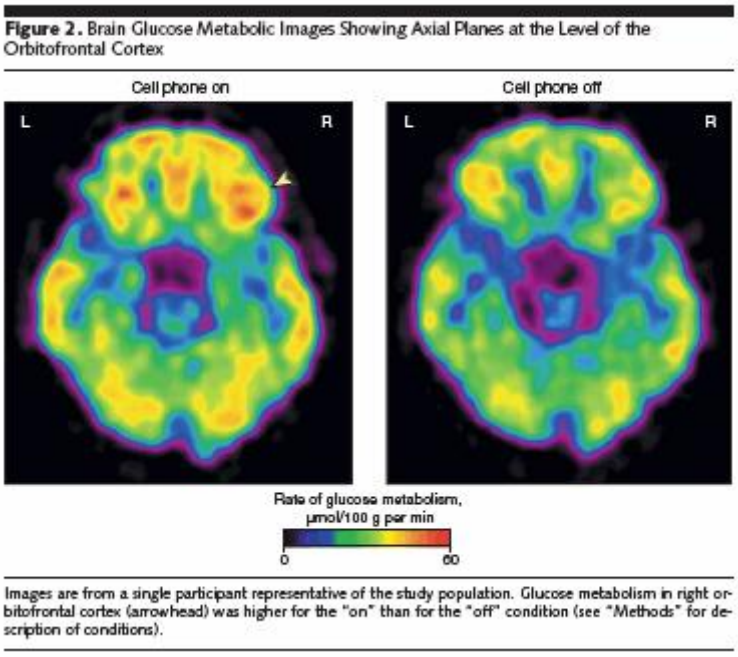
In fact, Volkow has some data suggesting that such chronic effects do occur: The most active users of cell phones were found to have the largest changes in glucose metabolism in those areas of the brain exposed to the phone radiation. ...
...
An acute, short-term effect alone would forever change the research landscape for electromagnetic field effects. For decades, the microwave community has been awash with reports that low-level radiation can lead to numerous neurological effects, such as leakage through the blood-brain barrier, changes in calcium in and

around brain cells and DNA breaks in the brains of exposed animals. But in each case skeptics have countered that they could not repeat the experiments and therefore the original work must have been flawed and should be repudiated. Volkow's new study will no doubt face a similar barrage of criticism.

Cell Phone Brain Scans

In the study, 47 healthy subjects, nearly evenly split between men and women, were outfitted with a cell phone on each ear. Glucose metabolism was measured using PET scans, a technique first developed at BNL in the 1970s. Each participant was scanned twice, once when the right-hand phone was turned on and once when both phones were off (the phones were kept muted and the subjects were unaware when one of the phones was active). The phone exposures lasted 50 minutes and the PET scans were started five minutes after the phone was turned off. They reflect the average brain activity over a 30-minute period.

Although glucose metabolism was not altered for the brain as a whole, there were significant effects in those locations closest to the phone, the right orbitofrontal cortex (see the arrowhead in the figure on the left below) and parts of the temporal lobe. These areas of the brain have been shown to have the highest RF radiation exposures when using a mobile phone. As Volkow explains in the paper: The "regions expected to have the greatest absorption of RF-EMFs from the cell phone exposure were the ones that showed the larger increases in glucose metabolism."



The scan on the left is after a 50-minute cell phone exposure. Note the greater metabolic activity in the right orbitofrontal cortex (marked by the arrow). The scan on the right was made when the phone was off. The regions in red are those with the highest rates of glucose metabolism.
Source: Journal of the American Medical Association, 305, *p.811, February 23, 2011*

The observed increases were "similar in magnitude" to those reported after transcranial magnetic stimulation, a treatment for depression, according to the NIH-BNL researchers. Their new study is one of many they have carried out over the last decade. Last year, they published a paper in *NeuroImage* showing reduced metabolic activity in some regions of the brain during an MRI scan. Their emphasis has most often been on the effects of drugs on the brain.

The NIH-BNL team used two Samsung cell phones (model SCH-U310), transmitting and receiving CDMA signals, with a maximum specific absorption rate (SAR) of 0.901 W/Kg in the head. That is **substantially lower than the U.S. FCC's limit of 1.6 W/Kg for hand-held cell phones**. (Emphasis added.)

...

Volkow's new study is bound to draw a great deal of attention, if only because she is something of a science superstar. She has a high media profile, turning up on numerous lists of the influential and powerful, including *Time* magazine's "Top 100 People Who Shape Our World" (2007) and *Washingtonian* magazine's "100 Most Powerful Women" (2009). A decade ago, Volkow was named "Innovator of the Year" by *U.S. News and World Report.* In 2003, when she left a senior position at BNL to become the head of NIDA, Volkow was the subject of a glowing profile in *JAMA,* which credited her as having authored "dozens of pioneering brain imaging studies." Today, she has published more than 440 peer-reviewed articles and 75 book chapters, according to her official NIH profile. ...

NIDA Director Volkow Endorses Precaution

In an e-mail exchange with *Microwave News,* Volkow said that she recommends taking precautionary measures. "Because we are uncertain of whether there are or are not long term consequences," she stated, "my recommendation is to use a wired earpiece, use the cell phone in speaker phone mode or text message." Volkow is the highest-ranking health official in the U.S. to call for caution in the use of cell phones.

The closing sentence of original version of the *JAMA* paper advised cell phone users to keep the antenna away from the brain by using a wired earpiece. This was edited out in the review/revision process.

[RFR changes brain metabolism - End quote]

EXHIBIT 19A-2 (FD):
Connecting the Dots: Putting the Volkow Brain Scans in Perspective. Microwave News, March 8, 2011.
https://microwavenews.com/Achermann.html

Article confirms that there had been other studies, pre-dating the Volkow study by a decade, which showed significant changes in brain activity from short-term exposures to RF radiation.

In 2002, as reported in the *Journal of Sleep Research* under the title, *Cell Phones Affect Brain Activity*, researcher Peter Achermann found changes in cerebral blood flow following exposure to cell phone RF radiation.

Article further reads in part:

[Connecting the dots - Begin quote]

Beyond showing changes in blood flow and EEG, Achermann has also shown that a brain excited by cell phone radiation manifests sleep differently. Working with his mentor, Alexander Borbély, an internationally respected authority on sleep, Achermann published his first cell phone sleep study in 1999. When they published a follow-up study in *NeuroReport* the following year, the journal commissioned a commentary to accompany their paper. "**These results show that even a short exposure to EMFs emitted by cellular telephones can affect brain physiology**," the editorial cautioned. In an interview with *Microwave News* at the time, Achermann said that the observed effect originates "**deep inside the brain**" (see *MWN*, N/D00, pp.6-7). (Emphasis added.)

Achermann is not alone. In 2006, a Finnish group, also using PET scans, exposed the brain with commercial cell phones and saw changes in cerebral blood flow. The Finns concluded that the results are "consistent" with "changes in neural activity." Even before that, the U.K. government distributed a public education leaflet that advised: "[T]he research does show that using mobile phones affects brain activity."

But it is Achermann's sleep work that has prompted the most attention. At this point, at least three other labs have also shown that mobile phone radiation affects sleep. (**They provide more evidence against the convenient fiction that there are no repeatable low-level effects**.) (Emphasis added.)

None of this escaped the phone industry's notice. FGF, the now defunct German trade group, hosted three different workshops on cell phones and sleep and brain function: one in 2003, another in 2007 and a third in 2009. The MMF, an international industry group, sponsored its own study by a team of Swedish-American researchers led by Bengt Arnetz. They too found support for Achermann. Arnetz's results, first announced back in the fall of 2007 (see "GSM Radiation Disrupts Sleep: An Emerging Low-Level Effect"), were finally published this January, after a long gestation period.

[Connecting the dots - End quote]

EXHIBIT 20E (FD):
A Report on Non-Ionizing Radiation: 'Science' Gets It Wrong on DNA Breaks. Microwave News, September 3, 2008. Article criticizes another article published in the magazine, *Science*, for distorted reporting about the number of published studies with positive findings of DNA breaks associated with exposure to RF fields from cell phones. Correcting this misinformation by citing numerous such studies, the Microwave News article reads in part: "[C]learly, to state that only two papers have shown DNA breaks is grossly misleading—no, simply wrong."

EXHIBIT 21A-1 (FD):
Cell phone radiation and malignant brain tumors. *60 Minutes Australia* news report: Includes interviews of neurosurgeon Dr. Charles Teo and Dr. Vini Khurana, who, along with Dr. Lennart Hardell and others, conducted an epidemiological study which concluded that long-term use of mobile phones is associated with a doubling of certain types of brain tumors. Dr. Khurana stated that he believes 'doubling' to be "a conservative estimate". Supporting research study and report data are in **EXHIBITS 21A-2 and 21A-3**, respectively.

EXHIBIT 21B-1 (FD):
How Big Wireless Made Us Think That Cell Phones Are Safe. The *Nation*. Discussion reveals in detail how the cell phone industry cherry-picked the science and "war-gamed" the research on risks of exposure to radiofrequency radiation from cell phones. Includes commentary on the recently-released, peer-reviewed final report of the U.S. National Toxicology Program (**NTP**) which found "clear evidence" that radiofrequency radiation causes cancer.

EXHIBIT 21B-2 (FD):
How Big Wireless Made Us Think That Cell Phones Are Safe: A Special Investigation. The *Nation*. In-depth article explores how the wireless industry adopted a sordid disinformation campaign, using tactics from the tobacco and fossil-fuel industries' 'playbooks' to successfully create doubt in the minds of the public that radiation emitted by cell phones could be unsafe. Reads in part:

"This *Nation* investigation reveals that the wireless industry not only made the same moral choices that the tobacco and fossil-fuel industries did; it also borrowed from the same public-relations playbook those industries pioneered. The playbook's key insight is that an industry doesn't have to win the scientific

argument about safety; it only has to keep the argument going. That amounts to a win for the industry, because the apparent lack of certainty helps to reassure customers, even as it fends off government regulations and lawsuits that might pinch profits.

"Central to keeping the scientific argument going is making it appear that not all scientists agree. Again like the tobacco and fossil-fuel industries, the wireless industry has "war gamed" science, as a Motorola internal memo in 1994 phrased it. War-gaming science involves playing offense as well as defense: funding studies friendly to the industry while attacking studies that raise questions; placing industry-friendly experts on advisory bodies like the World Health Organization; and seeking to discredit scientists whose views depart from the industry's.

"Funding friendly research has perhaps been the most important component of this strategy, because it conveys the impression that the scientific community truly is divided. Thus, when studies have linked wireless radiation to cancer or genetic damage—as Carlo's WTR did in 1999; as the WHO's Interphone study did in 2010; and as the US National Toxicology Program did in 2016—industry spokespeople can point out, accurately, that other studies disagree. "[T]he overall balance of the evidence" gives no cause for alarm, asserted Jack Rowley, research and sustainability director for the Groupe Special Mobile Association (GSMA), Europe's wireless trade association, speaking to reporters about the WHO's findings.

"A closer look reveals the industry's sleight of hand. When Henry Lai, the professor whom Carlo tried to get fired, analyzed 326 safety-related studies completed between 1990 and 2005, he learned that 56 percent found a biological effect from cell-phone radiation and 44 percent did not; the scientific community apparently was split. But when Lai recategorized the studies according to their funding sources, a different picture emerged: 67 percent of the independently funded studies found a biological effect, while a mere 28 percent of the industry-funded studies did. Lai's findings were replicated by a 2007 analysis in *Environmental Health Perspectives* that concluded industry-funded studies were two and a half times less likely than independent studies to find a health effect.

"One key player has not been swayed by all this wireless-friendly research: the insurance industry. *The Nation* has not been able to find a single insurance company willing to sell a product-liability policy that covered cell-phone radiation. "Why would we want to do that?" one executive chuckled before pointing to more than two dozen lawsuits outstanding against wireless companies, demanding a total of $1.9 billion in damages. Some judges have affirmed such lawsuits, including a judge in Italy who refused to allow industry-funded research as evidence.

"**Lack of definitive proof that a technology is harmful does not mean the technology is safe**, yet the wireless industry has succeeded in selling this logical fallacy to the world. ... Meanwhile, the wireless industry has obstructed a full and fair understanding of the current science, *aided by government agencies that have prioritized commercial interests over human health* and news organizations that have failed to inform the public about what the scientific community really thinks. In other words, this public-health experiment has been conducted without the informed consent of its subjects, even as the industry keeps its thumb on the scale.

"'**The absence of absolute proof does not mean the absence of risk**' ...

"The wireless industry has sought to downplay concerns about cell phones' safety, and the Federal Communications Commission has followed its example. In 1996, the FCC established cell-phone safety levels based on "specific absorption rate," or SAR. Phones were required to have a SAR of 1.6 watts or less per kilogram of body weight. In 2013, the American Academy of Pediatrics advised the FCC that its guidelines "do not account for the unique vulnerability and use patterns specific to pregnant women and children." Nevertheless, the FCC has declined to update its standards.

"The FCC has granted the industry's wishes so often that it qualifies as a **"captured agency,"** argued journalist Norm Alster in a report that Harvard University's Edmond J. Safra Center for Ethics published in 2015. ...

"The revolving-door syndrome that characterizes so many industries and federal agencies reinforces the close relationship between the wireless industry and the FCC. Just as Tom Wheeler went from running the CTIA (1992– 2004) to chairing the FCC (2013–2017), Meredith Atwell Baker went from FCC commissioner (2009–2011) to the presidency of the CTIA (2014 through today). To ensure its access on Capitol Hill, the wireless industry made $26 million in campaign contributions in 2016, according to the Center for Responsive Politics, and spent $87 million on lobbying in 2017.

"Neutralizing the safety issue has been an ongoing imperative because the research keeps coming, much of it from outside the United States. But the industry's European and Asian branches have, like their US counterpart, zealously war-gamed the science, spun the news coverage, and thereby warped the public perception of their products' safety." (Underlining , italics and emphasis added.)

EXHIBIT 21B-10 (FD):
The Real Junk Science of EMFs. Microwave News, November 23, 2009 issue. Reads in part:

"[Leeka] Kheifets and Swanson's paper is worse than junk science, it's fraud. The paper seeks to give the electric industry a major prize by taking electric fields off the EMF health agenda. This is, by any reasonable definition, scientific misconduct, and is far more serious than any of the cases that have been pursued by those who police scientific integrity (see "Three Cases of Alleged Scientific Misconduct").

"Far from ever being challenged, Kheifets has been and continues to be in great demand. She has helped shape every major EMF risk evaluation in recent memory. Swanson has been invited to attend many of the same meetings.

"ICNIRP, which touts itself as being free of industry ties, has had Kheifets on its Standing Committee on Epidemiology for the last seven years. The committee publishes influential literature reviews on health risks, including the possible links between power lines and cancer.

"Back in 2001, IARC, the International Agency for Research on Cancer, though fully aware that Kheifets worked for EPRI, invited her to sit on its committee evaluating EMF cancer risks as a full voting member. IARC also welcomed Swanson to sit in as an observer. According to those who were at the meeting, Swanson participated in the deliberations no differently that he would have as a member of the committee.

"Soon afterwards Kheifets joined Mike Repacholi at WHO's EMF Project in Geneva. EPRI continued to support her while she was at the WHO, even though this was in apparent violation of WHO rules governing conflicts of interest ... ."

EXHIBIT 21B-11 (FD):
Time to Stop the WHO [EMF] Charade. Microwave News, Vol. XXV No. 3, June-December 2005. Reads in part:

"Now we know what Mike Repacholi has been doing since the infamous Mike-and-Leeka flip-flop of 2003. Back then Repacholi and his assistant Leeka Kheifets decided that there was no need to apply the precautionary principle to EMFs—soon after telling everyone that the time for action had finally arrived.

"It appears that for the last two-and-a-half years, when not shuttling from one meeting to another, Mike has been cataloguing ways the WHO can avoid taking precautionary steps to reduce EMF exposures."
...
"Back in early 2003, there were enough reasons to invoke the precautionary principle for power-frequency EMFs and for RF from mobile phones. Over the last year, more studies have reaffirmed the need for caution. Three different data sets now implicate long-term use of mobile phones with acoustic tumors: Two from the Öreboro group and one from the Karolinska group. The University of Vienna has found support for Henry Lai and NP Singh's studies showing that RF radiation can break DNA—these results from the REFLEX research program indicate that RF radiation may well be genotoxic after all. And even more recently, an Australian researcher reported additional evidence that RF can break up DNA."
...
"When the REFLEX DNA work first hit the media, Mays Swicord ... at Motorola didn't have to say a word because their man in Geneva, Mike Repacholi of the World Health Organization, was ready to speak for them. Mike offered immediate reassurances that the Vienna results are spurious and may be discounted. 'One has to question what went wrong, or was different, for them to get the results they claim,' Mike told the *New Scientist*."

EXHIBIT 21B-12 (FD):
"Radiation Research" and The Cult of Negative Results: A Microwave News Investigation. Microwave News, Vol. XXVI No. 4, July 31, 2006. Reads in part:

"*Radiation Research* is a scientific journal whose primary focus is on ionizing radiation, with only a minority of papers devoted to the non-ionizing side of the electromagnetic spectrum. Its June issue, however, features five papers, all of which claim to show that EMFs of one type or another have no biological effects.

"To account for this departure from the norm, Sara Rockwell, the editor-in chief, Bruce Kimler, an associate editor, and John Moulder, a senior editor, have offered an apologia, under the title, "Publishing Negative Results." (In this context, "negative results" refers to studies that show no effects.) The editors want you to believe that they are offering this bumper crop of negative papers as a public service. They are on a mission, they say, to allay "widespread concern" over power lines and cell phones by giving a voice to those who, despite great effort, could not substantiate previously reported findings of 'deleterious health effects.'

"The editorial tacitly concedes that *Radiation Research* only rarely publishes papers showing any type of EMF effects by failing to cite a single example from its own pages. At the same time, it fails to mention that other journals, for instance

Mutation Research and *Bioelectromagnetics*, have had no trouble finding high-quality papers with "positive" results —that is, those that *do* show biological effects.

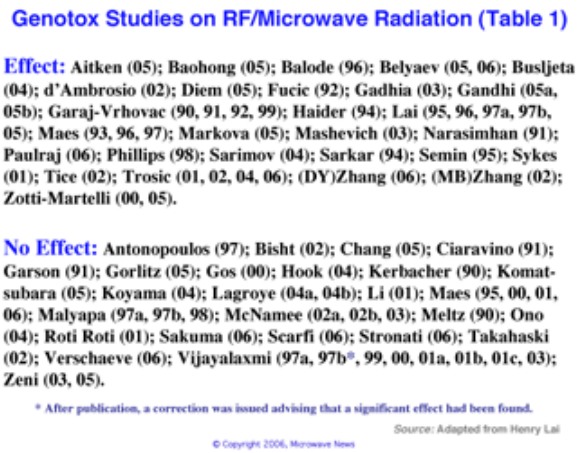
"Many of the negative EMF studies that have been published in *Radiation Research* were paid for by industry ... which seek to control EMF research (often by stopping it) and to show that microwaves are essentially harmless except at high exposure levels. Promoting no-effect studies has long been part of their strategy to keep a lid on the microwave-health controversy.

"**Wireless companies like Motorola have fostered** the **spurious view that negative studies cancel out positive ones**. Their strategy is this: First, seed the journals with no-effect papers that run counter to previously published work which does show biological changes. Then argue: 'If we couldn't replicate the effect, it cannot be real.' The assumption here is that industry science is superior to everyone else's. They make no effort to resolve inconsistent results. (Underlining and emphasis added.)

"Another important fact goes undisclosed in the editorial: One of its authors, John Moulder ... has a lucrative consulting practice on EMFs and health. Over the years, Moulder has earned hundreds of thousands of dollars disputing the existence of adverse EMF health effects, even those accepted by most other members of the EMF community.

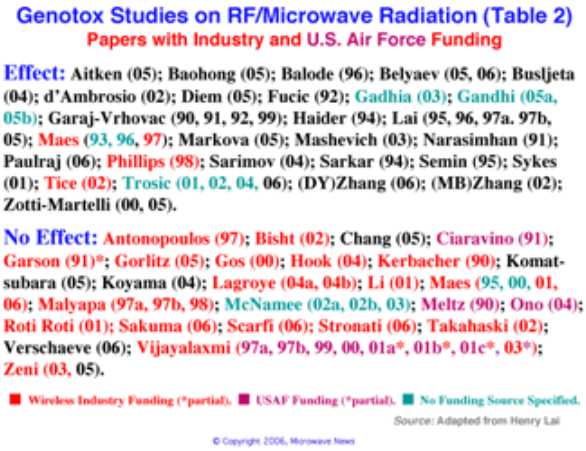
"To explore the potential biases at work, *Microwave News* investigated a subset of health studies published in peer-reviewed scientific journals. We selected papers on microwave-induced genotoxicity; that is, microwave effects on DNA, the genetic blueprint inside every living cell. With the generous help of Henry Lai of the University of Washington, Seattle, we identified 85 radiofrequency (RF)/microwave-genotox papers published since 1990. Of these, 43 found some type of biological effect and 42 did not.

"Lai is an interested party to this controversy. Together with N.P. Singh, Lai made RF/microwave genotoxicity a major concern when, in the mid-1990's, they were the first to report that microwaves could lead to DNA single- and double-strand breaks. As you can see in Table 1, Lai is the lead author of four of the 43 'effect' or positive studies.



[Click on each table to download a pdf]

"There is just about an even split between effect and no-effect papers. But look what happens when we superimpose the funding source for each study (where available): Those sponsored by industry are in red and those sponsored by the U.S. Air Force are in purple in Table 2. (Papers with no declared funding source are in green.)



"A clear —and disconcerting— pattern emerges: 32 of the 35 studies that were paid for by the mobile phone industry and the U.S. Air Force show no effect. They make up more than 75% of all the negative studies. You don't need to be a statistician to infer that money, more often than not, secures the desired scientific result.

"One of the three industry studies that did find an effect nearly failed to make it into print. It was carried out by Jerry Phillips under a Motorola contract. Motorola opposed Phillips' decision to write up his positive findings and, according to Phillips, the company tried to stop him. Phillips resisted and succeeded, but it was the last piece of original EMF research he ever completed.

"A similar loss of balance occurs when you look at only the papers published in *Radiation Research.* These are colored orange in Table 3.

Genotox Studies on RF/Microwave Radiation (Table 3)
Papers Published *in Radiation Research*

Effect: Aitken (05); Baohong (05); Balode (96); Belyaev (05, 06); Busljeta (04); d'Ambrosio (02); Diem (05); Fucic (92); Gadhia (03); Gandhi (05a, 05b); Garaj-Vrhovac (90, 91, 92, 99); Haider (94); Lai (95, 96, 97a, 97b, 05); Maes (93, 96, 97); Markova (05); Mashevich (03); Narasimhan (91); Paulraj (06); Phillips (98); Sarimov (04); Sarkar (94); Semin (95); Sykes (01); Tice (02); Trosic (01, 02, 04, 06); (DY)Zhang (06); (MB)Zhang (02); Zotti-Martelli (00, 05).

No Effect: Antonopoulos (97); Bisht (02); Chang (05); Ciaravino (91); Garson (91); Gorlitz (05); Gos (00); Hook (04); Kerbacher (90); Komatsubara (05); Koyama (04); Lagroye (04a, 04b); Li (01); Maes (95, 00, 01, 06); Malyapa (97a, 97b, 98); McNamee (02a, 02b, 03); Meltz (90); Ono (04); Roti Roti (01); Sakuma (06); Scarfi (06); Stronati (06); Takahaski (02); Verschaeve (06); Vijayalaxmi (97a, 97b, 99, 00, 01a, 01b, 01c, 03); Zeni (03, 05).

■ Published in *Radiation Research.*

Source: Adapted from Henry Lai

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"Over the last 16 years, only one positive paper on microwave genotoxicity has appeared in *Radiation Research.* During the same time, the journal has published 21 negative genotox papers. (Australia's Pam Sykes, the lead author of the lone positive paper, was denied money for a follow-up and soon moved on to other research areas.)

"When Tables 2 and 3 are combined, you can see that 80% of the negative papers (17 out of 21) published in *Radiation Research* were paid for by either industry or the U.S. Air Force. These are in red in Table 4.

Genotox Studies on RF/Microwave Radiation (Table 4)
***Radiation Research* Papers Sponsored by Industry and/or USAF**

Effect: Aitken (05); Baohong (05); Balode (96); Belyaev (05, 06); Busljeta (04); d'Ambrosio (02); Diem (05); Fucic (92); Gadhia (03); Gandhi (05a, 05b); Garaj-Vrhovac (90, 91, 92, 99); Haider (94); Lai (95, 96, 97a, 97b, 05); Maes (93, 96, 97); Markova (05); Mashevich (03); Narasimhan (91); Paulraj (06); Phillips (98); Sarimov (04); Sarkar (94); Semin (95); Sykes (01); Tice (02); Trosic (01, 02, 04, 06); (DY)Zhang (06); (MB)Zhang (02); Zotti-Martelli (00, 05).

No Effect: Antonopoulos (97); Bisht (02); Chang (05); Ciaravino (91); Garson (91); Gorlitz (05); Gos (00); Hook (04); Kerbacher (90); Komatsubara (05); Koyama (04); Lagroye (04a, 04b); Li (01); Maes (95, 00, 01, 06); Malyapa (97a, 97b, 98); McNamee (02a, 02b, 03); Meltz (90); Ono (04); Roti Roti (01); Sakuma (06); Scarfi (06); Stronati (06); Takahaski (02); Verschaeve (06); Vijayalaxmi (97a, 97b, 99, 00, 01a, 01b, 01c, 03); Zeni (03, 05).

■ Published in *Radiation Research* and supported by industry and/or the U.S. Air Force.

Source: Adapted from Henry Lai

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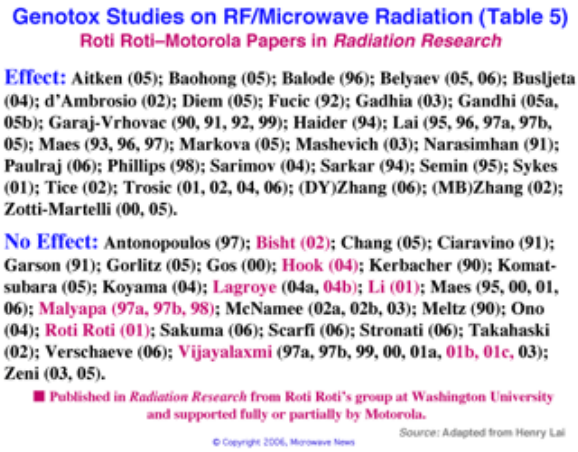
"And of these 17, most are associated with a single lab: Joe Roti Roti's at Washington University in St. Louis. Roti Roti's principal funding source is Motorola. The 10 Roti Roti–Motorola papers on RF/microwave genotoxicity are in pink in Table 5.



"In addition, many other Roti Roti papers on other types of microwave effects, also paid for by Motorola, have been published in *Radiation Research.* With respect to microwave radiation, it almost appears as if *Radiation Research* is a house organ of the Motorola Corporation."

...

"Back in 2001 after Moulder had moved up to senior editor, he recruited Vijayalaxmi of the University of Texas in San Antonio to join the *Radiation Research* editorial board. A couple of years earlier they, together with some colleagues from Washington University and the U.S. Air Force, had published a review paper that dismissed any possible connection between cell phones and cancer. This too was published in *Radiation Research.*

"As shown in Table 2, Vijayalaxmi is the lead author on seven of the microwave-genotox papers. All were funded by the U.S. Air Force, Motorola or a combination of the two.

"Last year, while she was still an associate editor at *Radiation Research* (she stepped down soon afterwards), Vijayalaxmi together with Sheila Johnston, a long-time consultant to the mobile phone industry based in London, launched an aggressive assault against Lai and Singh and their work on genotoxicity. In an e-mail accompanying their analysis of Lai–Singh's research, Johnston wrote: 'Lai's science has failed CONCLUSIVELY' [her emphasis]. The Vijayalaxmi–Johnston rant was so amateurishly written that it was largely ignored. What's harder to forget is the virulence of their attack. 'They are not scientific statements,' Singh told us at the time, 'they are personal attacks. They do not want to solve problems, they want to eliminate us.'"

...

"At a time when potential conflicts of interest among authors of medical and scientific papers are front page news (see, for instance, the July 11, 2006 *Wall Street Journal* on a paper published by the *Journal of the American Medical Association),* and more and more journals are requiring full disclosure of ties to

industry, it is surprising —no, astonishing— that a leading radiation journal allows such obvious conflicts to remain unacknowledged. An editorial in the Sunday *New York Times* on July 23, said that the 'best hope' for the credibility of medical journals is for them "to try much harder to find authors free of conflicts."

EXHIBIT 21B-18 (FD):
Wi-Fried: Children and Wireless Devices. Australian ABC TV report by Dr. Maryanne Damasi. In this excerpt from the report, Frank Clegg, former CEO Microsoft Canada, comments on the machinations of the wireless industry. Mr. Clegg states in part:

"I've been in the industry all my career, and I've seen the tremendous benefits that technology can provide. My concern is: nobody can say that it's safe. **All my industry and all government agencies say is there's no proof of harm, and** to my mind, **that's not the same as saying it's safe**.

"Unfortunately, the safety standards in North America and Australia are based on this theory that's many decades old -- that if tissue doesn't get heated, then it can't cause harm. And that's just out of date. And what the biologists tell us and have shown in many, many experiments and again, peer-reviewed, published papers, that there is damage done at the DNA level, and from a biological standpoint, is non-thermal radiation can cause, and does cause, harm to humans.

"Any government agency, in my opinion, that has done a review in the last two or three years, and hasn't made a significant change to their safety standard, has not done a proper and thorough review of the science. ... If you can't say it's safe, then you be cautious how you use it.

"I am embarrassed to say that **I believe my industry is on a campaign to bury the science and to confuse the message on the harmful effects of wireless devices**.

"One of the best analogies that I've heard in this scenario is using the tobacco model where we know that the first science came out showing that cigarettes cause harm back in the 1960s. And **the tobacco industry was able to delay legislation, delay the message to the public for decades**.

"**I believe that my industry is using that same model in obfuscating the science, confusing government** and causing government to be constipated and not passing the legislation that they need to pass."

EXHIBIT 21C-4 (FD):
EPA Staff Classifies ELF EMFs 'Probable Human Carcinogens'. Microwave News, Vol. X No. 3, *A Report on Non-Ionizing Radiation*, May/June 1990. The government scientists, who had determined as early as 1990 that the evidence was sufficient for these EMFs to be classified as "probable human carcinogens," were bureaucratically overruled. The administrative rationale put forth was that a mechanism of interaction and an observed dose-response relationship were not yet known. This serves to illustrate a tactic typically used to protect the commercial interests of industry over the health and safety of the public. It is certainly not necessary for a mechanism or dosage-response relationship to be known or entirely understood in order for an agent to be appropriately classified, given sufficient evidence, with regard to its carcinogenicity. Cigarette tobacco was designated a human carcinogen before a dose-response relationship was firmly established and long before possible mechanisms were adequately elucidated and understood.

As Microwave News had reported, "As late as March 12,1990, the paragraph below concluded the executive summary of the EPA report. A few days later, it was deleted."

"Concerning exposure *to* fields associated with 60 Hz electrical power distribution, **the conclusion reached in this document is that such exposure is a 'probable' carcinogen risk factor, corresponding to a 'B1' degree of evidence that it is a risk factor**. This conclusion is based on 'limited' evidence of carcinogenicity [in] humans which is **supported by laboratory research indicating that the carcinogenic response observed in humans has a biological basis**, although the precise mechanisms [are] only vaguely understood." (Underlining and emphasis added.)

The complete text of the report's Summary and Conclusions appears on pp.11-15 of **EXHIBIT 21C-4**.

EXHIBIT 21C-6 (FD):
1993 FDA Memo: Data "Strongly Suggest" Microwaves Can Promote Cancer. Microwave News, Vol. XXIII No. 1. January/February 2003. Reads in part:

[FDA internal memo - Begin quote]

In the spring of 1993 at the height of public concern over cell phone–brain tumor risks, Food and Drug Administration (FDA) biologists concluded that the available data "strongly suggest" that microwaves can "accelerate the development of cancer." This assessment is in an internal agency memo recently obtained by *Microwave News* under the Freedom of Information Act. "Of approximately eight

chronic [in vivo] animal experiments known to us, five resulted in increased numbers of malignancies, accelerated progression of tumors, or both," wrote Drs. Mays Swicord and Larry Cress of FDA's Center for Devices and Radiological Health (CDRH) in Rockville, MD. They also pointed to other evidence from laboratory (*in vitro*) studies that supported a cancer risk.

...

The fact remains, however, that the data which exist strongly suggest that MWs can, under at least some conditions, accelerate the development of malignant tumors. These *in vivo* data are also supported by *in vitro* data which have demonstrated not only malignant transformation but other effects on the cell's growth-control mechanisms.

[FDA internal memo - End quote]

In his electrical engineering doctoral thesis at the University of Maryland, Mays Swicord had produced important basic research which showed that RF signals at precisely the same frequency range being proposed for cell phones could disturb the DNA of cells deep within the brain.

EXHIBIT 22B (FD):

IARC Urged to Revisit RF Risk. Animal Studies Prompt Calls To Upgrade Classification to "Probably Carcinogenic" or Higher. Microwave News, April 24, 2019. Reads in part:

"**An advisory committee has recommended that the International Agency for Research on Cancer (IARC) reassess the cancer risks associated with RF radiation. This should be a 'high priority,' according to the panel's report**, which was issued last week." (Underlining and Emphasis added.)

...

"In May 2011, an IARC expert committee classified RF radiation as a possible human carcinogen [Group 2B]. Since then, the evidence has grown stronger. After the NTP and Ramazzini animal studies both showed higher rates of cancer among rats exposed to cell phone radiation, a number of observers argued that IARC should upgrade RF to a 'probable' cancer agent [Group 2A] or simply 'carcinogenic to humans' [Group 1]. ...

"Following the release of the Ramazzini Institute results last year, Fiorella Belpoggi, the principal investigator, called on IARC to take another look (see our story). Belpoggi is the director of the Institute's Research Center in Bologna, Italy and was a member of the IARC priorities panel."

...

"'It is very good news,' Tony Miller, an emeritus professor of epidemiology at the University of Toronto, wrote in an e-mail. He cited the substantial human epidemiology and animal evidence of carcinogenicity that has accrued since the 2011

evaluation. 'If a working group were to conclude that RF is a Group 1 human carcinogen, as many of us now believe,' he said, 'it would be impossible for governments and public health authorities to ignore.'"

EXHIBIT 24I (FD):
Major Cell Phone Radiation Study Reignites Cancer Questions. Scientific American. Reads in part:

"'This is by far—far and away—the most carefully done cell phone bioassay, a biological assessment.' ...
Based on these findings, Portier said that this is not just an associated finding—but that the relationship between radiation exposure and cancer is clear. **'I would call it a causative study, absolutely.** They controlled everything in the study. **It's [the cancer] because of the exposure.**'" (Dr. Christopher Portier is a retired head of the NTP who helped launch the study.) (Emphasis added.)
...
"'Probably what caused cancer at the high doses will cause cancer at lower doses but to a lesser degree,' Portier says."
...
"The fact that scientists were able to expose animals to nonionizing radiation (like that emitted by cell phones) and those animals went on to develop tumors but that exposure did not significantly raise the animals' body temperatures was 'important' to release, Bucher says." (John Bucher is the Associate Director of the NTP.)

Of course, in its response to the NTP study results, the CTIA issued the following entirely expected statement and pathetic, standard industry denial and spin:

"Numerous international and U.S. organizations including the U.S. Food and Drug Administration, World Health Organization and American Cancer Society have determined that the already existing body of peer-reviewed and published studies shows that there are no established health effects from radio frequency signals used in cellphones."

EXHIBIT 24J (FD):
ACS Responds to New Study Linking Cell Phone Radiation to Cancer. Commentary by Otis W. Brawley, MD, American Cancer Society Chief Medical Officer, on the NTP RF study. Reads in part:

"The new report covers only partial findings from the study, but importantly one of the two cancers linked to cell phone radiation was malignant gliomas in the brain. **The association with gliomas and acoustic neuromas had been suspected from human epidemiology studies**. The second cancer, called a schwannoma, is an

extremely rare tumor in humans and animals, **reducing the possibility that this is a chance finding**. (Underlining and emphasis added.)

...

"The NTP was given the difficult task of trying to answer important questions about the potential cancer risk posed by cell phones, and the group did not shirk from its responsibility. NTP staff were clearly aware of the potential importance of this study and went the extra distance to ensure the best science is used.

...

"NTP staff were clearly aware of the potential importance of this study and **went the extra distance to ensure the best science is used**. They used double the number of animals required for this type of study; they convened not one but three panels to look at abnormal tissues from treated animals to ensure that what was identified as a brain and heart tumor was indeed a brain and heart tumor; they solicited review from multiple scientists from outside the NTP to critically review all aspects of the data analysis and study findings, to ensure the findings would stand up to the critical assessment expected once these unexpected findings were released."

Genotoxic and carcinogenic effects of non-ionizing electromagnetic fields. A. Kocaman, G. Altun, A. Kaplan, O. Deniz, K. Yurt, S. Kaplan. Environmental Research 163 (**2018**) 71-79. (**EXHIBIT 44G.**) Reads in part:

"There is some confusion about the fact that the **[NTP] report** was issued as a partial report in 2016. The leaders of that program have explained that the report was issued as a partial report because they were quite concerned and surprised at these findings ***especially in the light of the human results showing similar increased cancers***." (Underlining, italics and emphasis added.)

EXHIBIT 24K (FD):

NTP: Cell Phone RF Breaks DNA — Consistent with Higher Tumor Counts 20 Years After Landmark Lai-Singh Study. Microwave News, September 8, 2016. Reads in part:

[RF Breaks DNA - Begin quote]

The NTP results provide "strong evidence for the genotoxicity of cell phone radiation," Ron Melnick told *Microwave News*. Melnick led the team that designed the NTP study; ... This "should put to rest the old argument that RF radiation cannot cause DNA damage," he said.

DNA breaks were also seen in the brains of the RF-exposed mice, though the increases were less pronounced than among the rats.

...

Michael Wyde, who runs the NTP RF project day-to-day, presented some preliminary results at the BioEM2016 meeting in Ghent, Belgium, in June and later that month at the NTP Board of Counselors meeting[*].

...

Melnick, who spent close to 30 years at NTP before retiring in 2009, offered a more direct answer: "Finding DNA damage in the brain of rats supports NTP's tumor data," he said.

...

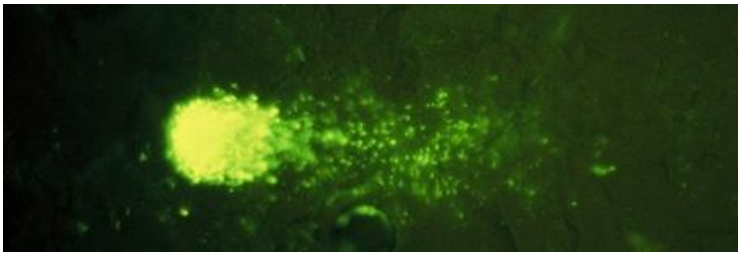
The Lai-Singh study was immediately challenged by the wireless companies as it threatened their central argument that cell phones cannot cause cancer.

...

Lai, who has retired from UW but still serves as the co-editor-in-chief of *Electromagnetic Biology and Medicine* (*EBM)* continues to keep close tabs on what others have been publishing. "There have been 73 studies on DNA breaks since our initial report," he told us in a recent interview, "**A clear majority has found an effect similar to ours**."[6] (Underlining and emphasis added.)

The Comet Assay

All 73 studies on Lai's list measured DNA damage using what's known as the comet assay.[7] The assay was developed by Singh, Lai's collaborator, close to 30 years ago.[8] It can detect single- and double-strand DNA breaks, as well as other potentially genotoxic changes. The assay gets its name from the comet-like tail formed by fragments of the broken DNA. The more DNA damage, the longer and more diffuse the tail (see an example below, image by N.P. Singh, provided by Henry Lai).



The comet assay is one of the standard techniques for evaluating genetic hazards — sometimes with DNA taken from animals (*in vivo*) and sometimes from cell cultures (*in vitro*). The assay is used routinely by the NTP for testing chemicals. The OECD, for instance, has called the comet assay carried out *in vivo* "especially relevant" for evaluating potential cancer agents. Both the original Lai-Singh and the new NTP studies used RF–exposed rats.

"An *in vivo* comet assay is usually more informative than an *in vitro* comet assay," said Raymond Tice. Back in the 1980's, Tice helped Singh develop the comet assay. He joined the NTP in 2005, becoming the chief of its Biomolecular Screening Branch ... .

...

Of the 73 RF–comet assay papers that Lai has catalogued, there are 28 studies that used *in vivo* exposures. "**Those showing DNA breaks outnumber those that don't by more than three to one**," he told us (22 vs. 6).[9] (Underlining and emphasis added.)

"**I have no doubt that low-intensity RF radiation is toxic to DNA**," Lai said. (Underlining and emphasis added.)

NTP's Genotoxicity Results

Before the NTP study got underway, Melnick's team targeted a number of the rats' body parts, including three regions of the brain, to be tested for DNA breaks. One of these was the frontal cortex of the brain, because, as Christine Flowers, NTP's Director of Communications, told us, it is "an area in which tumors were reported in humans."

Indeed, according to Melnick, the finding of brain cancer among cell phone users, as well as the original Lai-Singh DNA experiment, prompted him to include the DNA analysis as part of the NTP protocol. (Cell phone epidemiological studies led IARC to classify RF radiation as a possible human carcinogen in 2011.)

As it turned out, the frontal cortex is where the NTP saw the most significant increases in DNA breaks. (See ... Wyde's presentation at the BioEM2016 meeting in June.)

...

6. Of the 73 studies on Lai's list, **46 (63%) found an effect and 27 (37%) did not**. Lai and Singh have also shown that power-frequency (ELF) EMFs can cause DNA breaks (see their 1997 paper). Here again, Lai has catalogued the papers that followed their initial report. As of now, there have been 44 studies, of which **32 (73%) found an effect and 12 (27%) did not**. (Underlining and emphasis added.)

7. This summer, a team from Germany published a detailed review of the comet assay. Note that the assay is just one of a number of techniques used to measure genetic effects. Lai has also catalogued this larger RF-genotoxicity literature. At last count, in 2014, there was a total **of 125 papers, of which 84 (66%) showed effects and 41 (34%) did not**. (Underlining and emphasis added.)

8. Singh recently wrote up his reflections on the comet assay's development, evolution and applications.

9. Not taken into account in Lai's analysis is the funding source of the studies. For a discussion of industry, military and other influences on RF–DNA research, see our "*Radiation Research* and the Cult of Negative Studies," written ten years ago.

...

[*] At the same NTP Board of Scientific Counselors meeting, Linda Birnbaum, the director of NTP (& NIEHS), talked about the link between RF and the Schwannomas of the heart. In the video of the meeting, she **called the association 'unequivocally clear'** (@43:20-minute mark) and a few minutes later **described it as having a 'beautiful dose-relationship**.' A full set of videos from the meeting are here. (Underlining and emphasis added.)

[RF Breaks DNA - End quote]

The **Interphone Study** reports that "with as little as 1640 cumulative lifetime hours of wireless phone use, the risk of glioma is increased between 40% and 96% over controls. If one looks where one can reasonably expect to see early indications of glioma risk, there is increased risk for glioma at 10 years and longer use. The latency for brain tumors is 15-30 years. Seeing increased risk at only 10 years is indicative that cell phones are a highly effective carcinogen."

EXHIBIT 24M (FD):
Major Canadian Study Finds Cell Phone Use Significantly Increases Risk for Brain Cancer. Digital Journal, May 31, 2017. http://www.digitaljournal.com/pr/3364513#ixzz5uvX21gOE Reads in part:

"A new report published this week in American Journal of Epidemiology confirms that Canadians who have used cellphones for 558 hours or more have more than a doubled risk of brain cancer. These important findings strengthen the association between cell phone use and glioma, which is an aggressive brain cancer.

"The original 13-nation Interphone study for the International Agency for Research on Cancer of the World Health Organization reported a 40% increase in brain cancer for those using phones for 1640 lifetime hours. This new study found that Canadians had more than a doubled glioma risk when they were analyzed apart from the 12 other countries."

EXHIBIT 24O (FD):
Wi-Fried: Children and Wireless Devices. Australian ABC TV report by Dr. Maryanne Damasi. In this excerpt from the report, Dr. Damasi interviews Dr. Devra Davis, PhD, MPH, who states:

"With respect to mobile phones and brain cancer, the reality is: **every single well-designed study ever conducted finds an increased risk of brain cancer with the heaviest users. And the range of the risk is between 50 percent and 8-fold. That's a fact**."

EXHIBIT 29C-16 (FD):
Smart Meters: Correcting the Gross Misinformation. Article published by ***La Maison du 21e siecle***, dated June 11, 2012. https://ecfsapi.fcc.gov/file/7521097472.pdf and https://maisonsaine.ca/actualites/smart-meters-correcting-the-gross-misinformation.html Reads in part:

[Correcting the Gross Misinformation - Begin quote]

Quebec-based magazine La Maison du 21e siecle asked physician David O. Carpenter, former founding dean of the University at Albany (NY)'s School of Public Health, to comment an open letter published in the Montreal daily Le Devoir last May 24. This letter claimed wireless smart meters pose no risk to public health. More than fifty international experts contributed to the following rebuttal. (Underlining added.)

We, the undersigned are a group of scientists and health professionals who together have coauthored hundreds of peer-reviewed studies on the health effects of electromagnetic fields (EMFs). We wish to correct some of the gross misinformation found in the letter regarding wireless "smart" meters that was published in the Montreal daily *Le Devoir* on May 24. Submitted by a group Quebec engineers, physicists and chemists, the letter in question reflects an obvious lack of understanding of the science behind the health impacts of the radiofrequency (RF)/microwave EMFs emitted by these meters.

The statement that « Thousands of studies, both epidemiological and experimental in humans, show no increase in cancer cases as a result of exposure to radio waves of low intensity… » is false (1). In fact, only a few such studies — two dozen case-control studies of mobile phone use, certainly not thousands, have reported no elevations of cancer, and most were funded by the wireless industry. In addition, these reassuring studies contained significant experimental design flaws, mainly the fact that the populations followed were too small and were followed for a too short period of time. (Underlining and emphasis added.)

Non industry-funded studies have clearly demonstrated a significant increase in cancer cases among individuals who have suffered from prolonged exposure to

low-level microwaves, transmitted notably by radio antennas. The effects were best documented in meta-analyses that have been published and that include grouped results from several different studies: these analyses consistently showed an increased risk of brain cancer among regular users of a cell phone who have been exposed to microwaves for at least ten years.

...

Well-known bioeffects

While the specific pathways to cancer are not fully understood, it is scientifically unacceptable to deny the weight of the evidence regarding the increase in cancer cases in humans that are exposed to high levels of RF/microwave radiation.

The statement that « there is no established mechanism by which a radio wave could induce an adverse effect on human tissue other than by heating » is incorrect, and reflects a lack of awareness and understanding of the scientific literature on the subject. In fact, more than a thousand studies done on low intensity, high frequency, non-ionizing radiation, going back at least fifty years, show that some biological mechanisms of effect do not involve heat. This radiation sends signals to living tissue that stimulate biochemical changes, which can generate various symptoms and may lead to diseases such as cancer.

Even though RF/microwaves don't have the energy to directly break chemical bonds, unlike ionizing radiation such as X-rays, there is scientific evidence that this energy can cause DNA damage indirectly leading to cancer by a combination of biological effects. Recent publications have documented the generation of free radicals, increased permeability of the blood brain barrier allowing potentially toxic chemicals to enter the brain, induction of genes, as well as altered electrical and metabolic activity in human brains upon application of cell phone RF/microwaves similar to those produced by smart meters.

These effects are cumulative and depend on many factors including RF/microwave levels, frequency, waveform, exposure time, biovariability between individuals and combination with other toxic agents. Clear evidence that these microwaves are indeed bioactive has been shown by the fact that low-intensity EMFs have proven clinically useful in some circumstances. Pulsed EMFs have long been used to successfully treat bone fractures that are resistant to other forms of therapy. More recently, frequency-specific, amplitude-modulated EMFs have been found useful to treat advanced carcinoma and chronic pain. (Emphasis added.)

High frequency EMFs such as the microwaves used in cell phones, smart meters, Wi-Fi and cordless ‘‘DECT’’ phones, appear to be the most damaging when used commonly. **Most of their biological effects, including symptoms of electrohypersensitivity, can be seen in the damage done to cellular membranes**

by the loss of structurally-important calcium ions. Prolonged exposure to these high frequencies may eventually lead to cellular malfunction and death. (Emphasis added.)

...

Smart meters

As Australian Associate Professor of neurosurgery Vini G. Khurana reports, adverse neurological effects have been reported in people who sustain close proximity to wireless meters, especially under 10 feet (3 metres).

A wireless smart meter produces radiofrequency microwave radiation with two antennas in approximately the same frequency range (900 MHz to 2.4 GHz) as a typical cell tower. But, depending on how close it is to occupied space within a home, a smart meter can cause much higher RF exposures than cell towers commonly do. If a smart meter is located on a common wall with a bedroom or kitchen rather than a garage wall, for example, the RF exposure can be the same as being within 200 to 600 feet distance of a cell tower with multiple carriers. **With both cell towers and smart meters, the entire body is immersed by microwaves that go out in all directions, which increases the risk of overexposure to many sensitive organs such as the eyes and testicles.** With a cell phone, people are exposed to microwaves primarily in the head and neck (unless using speaker mode), and only when they use their device. (Emphasis added.)

Wireless smart meters typically produce atypical, relatively potent and very short pulsed RF/microwaves whose biological effects have never been fully tested. They emit these millisecond-long RF bursts on average 9,600 times a day with a maximum of 190,000 daily transmissions and a **peak level emission two and a half times higher than the stated safety signal, as the California utility Pacific Gas & Electric recognized before that State's Public Utilities Commission. Thus people in proximity to a smart meter are at risk of significantly greater aggregate of RF/microwave exposure than with a cell phone**, not to mention the cumulative exposure received by people living near multiple meters mounted together, pole-mounted routers or utility collector meters using a third antenna to relay RF signals from 500 to 5,000 homes. (Emphasis added.)

A technical study performed by Sage Associates in California indicates that RF levels from various scenarios depicting normal smart meter installation and operation may violate even the out-of-date US public safety standards which only consider acute thermal effects. This can happen when a person stands close to the meter to read the power consumption, or touches it, or shades the meter face with a hand to better read it. Emissions are also increased by reflective materials, such as stainless steel, other metals and mirrors, which can re-radiate stronger that the otherwise unaltered background. Microwaves are absorbed

and dissipated by partially conductive materials, such as cement and special RF shielding paints and fabrics.

In addition to the erratic bursts of modulated microwaves emitted by wireless smart meters ... are also a major source of ‘‘dirty electricity’’ (electrical interference of high frequency voltage transients typically of kilohertz frequencies). Some scientists, such as American epidemiologist Sam Milham, believe that many of the health complaints about smart meters may also be caused by **dirty electricity generated by the « switching » power supply activating all smart meters**.

...

1. Scientific papers on EMF health effects
2. Explanation and studies on electrosensitivity
3. Governments and organizations that ban or warn against wireless technology

• David O. Carpenter, MD, Director, Institute for Health & the Environment, University at Albany, USA

- Franz Adlkofer, M.D., Chairman of the Pandora Foundation, Coordinator of the European Reflex Report on DNA-damage by cellphone radiation, Neuendorf, Germany

• M. S. H. Al Salameh, PhD, Professor of Electrical Engineering, University of Science & Technology, Irbid, Jordan

• Jennifer Armstrong, MD, Past President, American Society for Environmental Medicine, Founder, Ottawa Environmental Health Clinic, Ontario, Canada

• Pierre L. Auger, MD, Occupational medicine, Multiclinique des accidentés 1464, Montreal, Quebec, Canada

• Igor Beliaev, PhD, Head research scientist, Cancer Research Institute, Slovak Academy of Sciences, Bratislava, Slovak republic

• Fiorella Belpoggi, PhD, Director Cesare Maltoni Cancer Research Center, Ramazzini Institute, Bologna, Italy

• Dominique Belpomme, MD, Director of the European Cancer and Environment Research Institute, Brussels, Belgium

• Martin Blank, PhD, former President, Bioelectromagnetics Society, Special Lecturer, Department of Physiology and Cellular Biophysics, Columbia University Medical Center, New York, USA

• Barry Breger, MD, Centre d’intégration somatosophique (orthomolecular medicine), Montreal, Quebec

• Simona Carrubba, PhD, Prof. Biophysics, Daemen College, Amherst, NY, Associate Researcher, Neurology, Buffalo General Hospital , Buffalo, NY

• John Cline, MD, Professor, Institute for Functional Medicine, Federal Way, WA, USA, Medical Director, Cline Medical Centre, Nanaimo, BC, Canada

• Alvaro Augusto de Salles, PhD, Professor of Electrical Engineering, Federal University of Rio Grande do Sul, Porto Alegre, Brazil

• Christos Georgiou, Prof. Biochemistry, Biology Department, University of Patras, Greece
• Andrew Goldsworthy, PhD, Honorary lecturer in Biology, Imperial College, London, UK
• Claudio Gómez-Perretta, MD, Director, Centro de Investigación, Hospital Universitario LA Fe, Valencia, Spain
• Livio Giuliani, PhD, Senior Researcher, National Insurance Institute (INAIL), Chief of Radiation and Ultrasounds Research Unit, Rome, Italy
• Yury Grigoriev, PhD, Chair Russian National Committee on Non-Ionizing Radiation Protection, Moscow, Russia
• Settimio Grimaldi, PhD, Director, Institute of Translational Pharmacology (Neurobiology and molecular medicine), National Research Council, Rome, Italy
• Magda Havas, PhD, Centre for Health Studies, Trent University, Canada
• Lennart Hardell, MD, Professor of Oncology, University Hospital, Örebro, Sweden
• Denis L. Henshaw, PhD, Professor of Physics, Head of The Human Radiation Effects Group, University of Bristol, UK
• Ronald B. Herberman, MD, Chairman of Board, Environmental Health Trust, and Founding Director emeritus, University of Pittsburgh Cancer Institute, USA
• Donald Hillman, PhD, Dairy Science, Professor Emeritus, Department of Animal Science, Michigan State University, USA
• Isaac Jamieson, PhD, Environmental Science (electromagnetic phenomena in the built environment), independent architect, scientist and environmental consultant, Hertfordshire, UK
• Olle Johansson, PhD, Professor of Neuroscience (Experimental Dermatology Unit), Karolinska Institute, Stockholm, Sweden
• Yury Kronn, PhD, Soviet authority on physics of nonlinear vibrations and high frequency electromagnetic vibrations, founder of Energy Tools International, Oregon, USA
• Vini G. Khurana, MBBS, Associate of Professor of Neurosurgery, Australian National University, Australia
• Henry Lai, PhD, Professor of Bioengineering, University of Washington School of Medicine, Seattle, WA, USA
• Abraham R. Liboff, PhD, Professor Emeritus, Department of Physics, Oakland University, Rochester, Michigan, USA
• Don Maisch, PhD, Researcher on radiation exposure standards for telecommunications frequency, EMFacts Consultancy, Tasmania, Australia
• Erica Mallery-Blythe, MD, Emergency Medicine Physician, England
• Andrew A. Marino, PhD, Professor of Neurology, LSU Health Sciences Center, Shreveport, LA, USA
• Karl Maret, MD, President, Dove Health Alliance, Aptos, CA, USA
• Fiorenzo Marinelli, PhD, Researcher on biological effects of EMFs, Institute of Molecular Genetics, National Research Council, Bologna, Italy

• Andrew Michrowski, PhD, Director, Planetary Association for Clean Energy, Ottawa, Canada
• Sam Milham, MD, former chief epidemiologist, Washington State Department of Health, USA
• Joel M. Moskowitz, PhD, Director, Center for Family and Community Health, School of Public Health, University of California, Berkeley
• Gerd Oberfeld, MD, Public Health Department, Salzburg State Government, Austria
• Mike O'Carroll, PhD, Professor Emeritus (Applied Mathematics), University of Sunderland, UK
• Jerry L. Phillips, PhD, Director, Center for Excellence in Science, Department of Chemistry and Biochemistry, University of Colorado, USA
• John Podd, PhD, Professor of Psychology (experimental neuropsychology), Massey University, New-Zealand
• William J. Rea, MD, thoracic and cardiovascular surgeon, founder of the Environmental Health Center, Dallas, Tx, USA
• Elihu D. Richter, MD, Professor, Hebrew University-Hadassah School of Public Health and Community Medicine, Jerusalem, Israel
• Leif G. Salford, MD, Senior Professor of Neurosurgery, Lund University, Sweden
• Nesrin Seyhan, MD, Founder and Chair of Biophysics, Medical Faculty of Gazi University, Turkey
• Cyril W. Smith, PhD, lead author of "Electromagnetic Man", retired from Electronic and Electrical Engineering, University of Salford, UK
• Morando Soffritti, MD, Scientific Director of the European Foundation for Oncology and Environmental Sciences "B. Ramazzini" in Bologna, Italy
• Carlos Sosa, MD, surgeon affected by the Microwave syndrome, Medellin, Columbia
• Antoinette "Toni" Stein, PhD, Collaborative on Health and the Environment (CHE-EMF Working Group), Co-Coordinator, Berkeley, CA, USA
• Stanislaw Szmigielski, MD, PhD Professor of Pathophysiology, Consulting Expert, former director of Microwave Safety, Military Institute of Hygiene and Epidemiology, Warsaw, Poland
• Lauraine Vivian, PhD, Senior Lecturer, Primary Health Care Directorate, Faculty of Health Sciences, University of Cape Town, South Africa.
• Bradford S. Weeks, MD, Director, The Weeks Clinic, Clinton, WA, USA
• Stelios A. Zinelis, MD, Vice-President, Hellenic Cancer Society, Cefallonia, Greece

[Correcting the Gross Misinformation - End quote]

8. Exhibits and Partial Transcripts in Proceedings of U.S. District Court Civil Action No. 3.11-cv-00739-MO

This section includes the following:

Exhibit Nos. 45D, 45I, 45J-1 through 45J-10, 45K, and 45L.

EXHIBIT 45D (FD):
Declaration of Dr. Magda Havas, BSc, PhD - Addendum A - Studies. (U.S. District Court Civil Action No. 3:11-cv-00739-MO.) 56 studies including human studies, animal (*in vivo*) studies, and *in vitro* studies categorized according to the following biological effects:

1. Neurological/Sleep/Learning/Behavior/Electrohypersensitivity [17studies]
2. Stress-Response/Hormonal-Response/Blood-Brain-Barrier/Immune System/Enzymes [9 studies]
3. Cardiac [8 studies]
4. Reproduction [7 studies]
5. Cancer/DNA Damage/Anti-oxidants/Death [15 studies]

EXHIBIT 45I (FD):
Amended Reply of Dr. Magda Havas, BSc, PhD, to Dr. David Savitz, PhD. (U.S. District Court Civil Action No. 3:11-cv-00739-MO.) Reads in part:

[Havas reply - Begin quote]

4. **Item 14 a.** We have many studies relevant to Wi-Fi, contrary to Dr. Savitz' assertion in Paragraph 23:

a. Laboratory studies that show that Wi-Fi (pulsed 2.4 GHz) causes cancer in rats *in vivo* (e.g., Chow et al. 1992). This is powerful evidence, as Dr. Savitz says in his Item 18 as it shows a cause–effect relationship rather than an association, as with epidemiological studies.

b. Studies with human subjects that show that pulsed 2.4 GHz radiation affects the heart (Havas et al 2010). This is also a cause–effect relationship.

c. Studies showing adverse effects on human sperm *(in vitro*) with Wi-Fi-enabled computers (Avendrano 2011).

d. Epidemiologic studies of infrastructure, such as those looking at communities near base stations and cell towers, showing adverse effects in both humans and animals, even where the frequencies/wavelengths transmitted do not produce as much absorption-per-exposure as does Wi-Fi at 2.4 GHz (Magras 1997; Loscher

and Kas 1998; Santini et al. 2002; Oberfeld 2008; Wolfe 2004; Eger 2004; Altpeter et al. 2006; Hutter et al. 2006; .

e. Studies *in vivo* with cell phone use;

f. See all my previous submissions for additional, primary-source, scientific evidence.

...

5. **Item 14 b** Regarding the citation in Paragraph 14b of the 2004 IEE Position Paper: the Position Paper's Appendix, which is asserted to include references, is not included publicly with the Paper; and there are no citations within the Paper's text. This Position Paper, moreover, is not peer-reviewed, and by its date cannot contain or be influenced by most of the recent decade's, 2002 - 2012, extant studies. Lacking accessible references, numerical citations and peer-review, the IEE Position Paper is unreliable and not a rigorous, scientific document. Even if it were a valid review, which it is not, it would in any case be outdated.

...

8. **Item 20,** Most of the RF/MW radiation-related documents that Dr. Savitz mentions are not peer-reviewed. Of the dozen peer-reviewed papers he references, all but one pertain specifically to cellphone use, and all have industry-military financial conflicts. Otherwise, Dr. Savitz has cited mostly blogs and industry magazine opinion pieces.

...

11. **Item 29**, (Per L. Lloyd Morgan, based on Sadetki (sic), and at his request for consistency:) Many types of brain tumors have a latency period of 20 to 30 years. The fact that brain tumors are being detected after 10 years of cell phone use, and after only 7 years in the most recent, and large INTERPHONE epidemiologic study released Jan 2, 2012, is significant (Cardis et al. 2012. Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries. Occup. Environ. Med. 68:631-640). There is a new increase in salivary gland tumors in Israel that is associated with cell phone use (Sadetki (sic) et al. 2008). **With cancer rates at 1-in-3 for women and 1-in-2 for men in the US, there is already a cancer epidemic and from a policy perspective no room to tolerate a new carcinogen or a new contributing factor to cancer**. (Emphasis added.)

12. Dr Savitz references redundantly two papers by **Dr. Ahlbom**, who was asked to step down from the IARC committee that recently reviewed the carcinogenic effects of RFR because of conflicts of interest. Ahlbom is cited in **items 8, 20m, 26, 29, 30 and 32**. See below: from www.microwavenews.com.

IARC Drops Anders Ahlbom from RF–Cancer Panel

May 22, 2011… *The International Agency for Research on Cancer (IARC) has removed Anders Ahlbom of the Karolinska Institute from its panel of experts which is set to evaluate the cancer risks posed by mobile phones. The committee will meet in Lyon, France, for a week beginning this coming Tuesday, May 24. In an e-mail sent out earlier today, Ahlbom wrote, "IARC has excluded me from the RF Working Group because of 'possible perception of conflict of interest'.*

"IARC moved quickly after learning that Ahlbom is a director of his brother's consulting firm, Gunnar Ahlbom AB. The company, which is based in Brussels, the European capital and a center for lobbyists, was established to help clients on telecom issues, with an emphasis on environmental and energy regulations. Ahlbom failed to mention this sideline in his "Declaration of Interests" that is required of all those who participate in IARC cancer assessments.

Apparently, IARC offered to allow Ahlbom to attend this week's meeting but only as a non-voting "invited specialist." Ahlbom declined to attend under those terms. He recently filed an amended declaration of his potential conflicts.

Mona Nilsson, a Swedish journalist who has written two books on mobile phones and health, unearthed Ahlbom's connection to his brother's company. She was about to post a press release on what she had found out when Ahlbom announced he would not be going to the IARC meeting after all. Nilsson says that this is good news. "Ahlbom absolutely should not be on the IARC expert group," she told Microwave News. http://www.microwavenews.com/Ahlbom.html.

[Havas reply - End quote]

EXHIBITS 45J-1 through 45J-10 (FD):
The following exhibits are the exhibits referenced in **EXHIBIT 45J** of the instant case that had been submitted as part of the proceedings of the State of Iowa Utilities Board (Docket No. SPU-2018-0007).
https://efs.iowa.gov/efs/SearchDocumentSearch.do

EXHIBIT 45J-1: Exhibits A, B, C, D, E, G, F referenced in EXHIBIT 45J
EXHIBIT 45J-2: Exhibit G referenced in EXHIBIT 45J
EXHIBIT 45J-3: Exhibits H, I, J, K, L, M referenced in EXHIBIT 45J
EXHIBIT 45J-4: Exhibits N, O, P, Q, R, S, T referenced in EXHIBIT 45J
EXHIBIT 45J-5: Exhibits U, V, W, X, Y referenced in EXHIBIT 45J
EXHIBIT 45J-6: Exhibits Z, AA, BB, CC, DD, EE referenced in EXHIBIT 45J
EXHIBIT 45J-7: Exhibits FF, GG, HH referenced in EXHIBIT 45J
EXHIBIT 45J-8: Exhibits II, KK, LL, MM, NN, OO referenced in EXHIBIT 45J
EXHIBIT 45J-9: Exhibits PP, QQ, RR, SS, TT, UU referenced in EXHIBIT 45J

EXHIBIT 45J-10: Exhibits VV, WW, XX, YY, ZZ referenced in EXHIBIT 45J

EXHIBIT 45K (FD):
Amended Declaration of Barrie Trower. (U.S. District Court Civil Action No. 3:11-cv-00739-MO.)
https://olis.leg.state.or.us/liz/2013I1/Downloads/CommitteeMeetingDocument/41774

EXHIBIT 45L (FD):
Second Amended Declaration of Curtis Bennett. (U.S. District Court Civil Action No. 3:11-cv-00739-MO.) http://www.magdahavas.com/wp-content/uploads/2012/01/Second-Amended-Declaration-of-Curtis-Bennett.pdf and https://ecfsapi.fcc.gov/file/7520958133.pdf

9. Exhibits and Partial Transcripts of Sources Reporting Conflicts of Interest and Influence of the Wireless Industry upon Scientific Committees and Regulatory and Policy-Making Agencies

This section includes the following:

Exhibit Nos. 18B, 21B-1, 21B-2, 21B-3, 21B-4, 21B-5, 21B-6, 21B-7, 21B-8, 21B-9, 21B-10, 21B-11, 21B-12, 21B-13, 21B-17, 21B-18, 21C-1, 21C-2, 29C-16, and 36B.

All of the exhibits listed within this section constitute directly relevant and highly credible evidence of reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria,* supra.

EXHIBIT 18B (FD):
Evaluation of Mobile Phone and Cordless Phone Use and Glioma Risk Using the Bradford Hill Viewpoints from 1965 on Association or Causation. Michael Carlberg and Lennart Hardell. BioMed Research International, Volume 2017, Article ID 9218486, https://doi.org/10.1155/2017/9218486. In this evaluation, Dr. Hardell also addresses the issue of industry influence and conflicts of interest among various international bodies charged with assessing safety and establishing standards for radiofrequency radiation. Of particular note is the fact 5 of 6 members of the WHO Monograph core group are also members of ICNIRP. Reads in part:

"No doubt the IARC decision started a worldwide spinning machine to question the evaluation, perhaps similar to the one launched by the tobacco industry when IARC was studying and evaluating passive smoking as a carcinogen in the 1990s [16]. Sowing confusion and manufacturing doubt is a well-known strategy used by the tobacco and other industries [17–19]; see also Walker [20]."

...

"ICNIRP is a private organization (NGO) based in Germany that selects its own members. Their source of funding is not declared. IEEE is the world's most powerful federation of engineers. The members are or have been employed in companies or organizations that are producers or users of technologies that depend on radiation frequencies, such as power companies, the telecom industry, and military organizations. IEEE has prioritized international lobbying efforts for decades especially aimed at the WHO."

...

"There are a vast number of scientific articles that show nonthermal adverse health effects from RF radiation."

...

"The guideline in the BioInitiative Report obviously contradicts the one proposed by ICNIRP. The ICNIRP exposure level has been vigorously propagated by that organization in order to harmonize guidelines worldwide. With few exceptions it has been a successful story and most countries have adopted the ICNIRP guideline. This gives a "green card" to roll out the technology with increasing RF radiation exposure to the population, for example, using wireless Internet access in schools [28], since the high exposure level in the guideline by ICNIRP is rarely compromised. Thus, the exposure target level in the BioInitiative Report is not acknowledged by, for example, the Swedish Radiation Safety Authority (SSM). Many persons at the SSM expert panel are also members of ICNIRP which might be a conflict of interests since they would rarely compromise the ICNIRP view; critical opinions are not heard. As a matter of fact the Ethical Board at the Karolinska Institute in Stockholm, Sweden, concluded already in 2008 that being a member of ICNIRP may be a conflict of interests that should be stated in scientific publications (Karolinska Institute Diary Number 3753-2008-609), which is however not done to our knowledge.

"An association between use of wireless phones and glioma has not been acknowledged by several scientific bodies in spite of the IARC classification in May 2011. This is exemplified below. In fact, as can be seen in Table 1 the same persons may appear in different expert groups. This would hardly make any substantial difference in the opinion between these groups. They may in fact cite themselves by claiming that various organizations have come to similar conclusion. It is striking how ICNIRP has infiltrated the WHO Monograph core group making it less likely that the conclusions in that Monograph will differ from ICNIRP's conclusions."

Table 1: Members of WHO Monograph core group and their involvement in different other groups.

Name	WHO	ICNIRP	UK/AGNIR	SSM	SCENIHR
Simon Mann	**X**	**X**	**X**		
Maria Feychting	**X**	**X**	**X**	**X***	
Gunnhild Oftedal	**X**	**X**			
Eric van Rongen	**X**	**X**		**X**	
Maria Rosaria Scarfi	**X**	**X***		**X**	**X**
Denis Zmirou	**X**				

* **Former**
WHO: World Health Organization.
ICNIRP: International Commission on Non-Ionizing Radiation Protection.
AGNIR: Advisory Group on Non-Ionising Radiation.
SSM: Strålsäkerhetsmyndigheten (Swedish Radiation Safety Authority).
SCENIHR: Scientific Committee on Emerging and Newly Identified Health Risks.

EXHIBIT 21B-1 (FD):
How Big Wireless Made Us Think That Cell Phones Are Safe. The *Nation*. Discussion reveals in detail how the cell phone industry cherry-picked the science and "war-gamed" the research on risks of exposure to radiofrequency radiation from cell phones. Includes commentary on the recently-released, peer-reviewed final report of the U.S. National Toxicology Program (**NTP**) which found "clear evidence" that radiofrequency radiation causes cancer.

EXHIBIT 21B-2 (FD):
How Big Wireless Made Us Think That Cell Phones Are Safe: A Special Investigation. The *Nation*. In-depth article explores how the wireless industry adopted a sordid disinformation campaign, using tactics from the tobacco and fossil-fuel industries' 'playbooks' to successfully create doubt in the minds of the public that radiation emitted by cell phones could be unsafe. Reads in part:

"This *Nation* investigation reveals that the wireless industry not only made the same moral choices that the tobacco and fossil-fuel industries did; it also borrowed from the same public-relations playbook those industries pioneered. The playbook's key insight is that an industry doesn't have to win the scientific argument about safety; it only has to keep the argument going. That amounts to a win for the industry, because the apparent lack of certainty helps to reassure customers, even as it fends off government regulations and lawsuits that might pinch profits.

"Central to keeping the scientific argument going is making it appear that not all scientists agree. Again like the tobacco and fossil-fuel industries, the wireless industry has "war gamed" science, as a Motorola internal memo in 1994 phrased it.

War-gaming science involves playing offense as well as defense: funding studies friendly to the industry while attacking studies that raise questions; placing industry-friendly experts on advisory bodies like the World Health Organization; and seeking to discredit scientists whose views depart from the industry's.

"Funding friendly research has perhaps been the most important component of this strategy, because it conveys the impression that the scientific community truly is divided. Thus, when studies have linked wireless radiation to cancer or genetic damage—as Carlo's WTR did in 1999; as the WHO's Interphone study did in 2010; and as the US National Toxicology Program did in 2016—industry spokespeople can point out, accurately, that other studies disagree. "[T]he overall balance of the evidence" gives no cause for alarm, asserted Jack Rowley, research and sustainability director for the Groupe Special Mobile Association (GSMA), Europe's wireless trade association, speaking to reporters about the WHO's findings.

"A closer look reveals the industry's sleight of hand. When Henry Lai, the professor whom Carlo tried to get fired, analyzed 326 safety-related studies completed between 1990 and 2005, he learned that 56 percent found a biological effect from cell-phone radiation and 44 percent did not; the scientific community apparently was split. But when Lai recategorized the studies according to their funding sources, a different picture emerged: 67 percent of the independently funded studies found a biological effect, while a mere 28 percent of the industry-funded studies did. Lai's findings were replicated by a 2007 analysis in *Environmental Health Perspectives* that concluded industry-funded studies were two and a half times less likely than independent studies to find a health effect.

"One key player has not been swayed by all this wireless-friendly research: the insurance industry. *The Nation* has not been able to find a single insurance company willing to sell a product-liability policy that covered cell-phone radiation. "Why would we want to do that?" one executive chuckled before pointing to more than two dozen lawsuits outstanding against wireless companies, demanding a total of $1.9 billion in damages. Some judges have affirmed such lawsuits, including a judge in Italy who refused to allow industry-funded research as evidence.

"**Lack of definitive proof that a technology is harmful does not mean the technology is safe**, yet the wireless industry has succeeded in selling this logical fallacy to the world. ... Meanwhile, the wireless industry has obstructed a full and fair understanding of the current science, *aided by government agencies that have prioritized commercial interests over human health* and news organizations that have failed to inform the public about what the scientific community really thinks. In other words, this public-health experiment has been conducted without the informed consent of its subjects, even as the industry keeps its thumb on the scale.

"'**The absence of absolute proof does not mean the absence of risk**' ...

"The wireless industry has sought to downplay concerns about cell phones' safety, and the Federal Communications Commission has followed its example. In 1996, the FCC established cell-phone safety levels based on "specific absorption rate," or SAR. Phones were required to have a SAR of 1.6 watts or less per kilogram of body weight. In 2013, the American Academy of Pediatrics advised the FCC that its guidelines "do not account for the unique vulnerability and use patterns specific to pregnant women and children." Nevertheless, the FCC has declined to update its standards.

"The FCC has granted the industry's wishes so often that it qualifies as a **"captured agency,"** argued journalist Norm Alster in a report that Harvard University's Edmond J. Safra Center for Ethics published in 2015. ...

"The revolving-door syndrome that characterizes so many industries and federal agencies reinforces the close relationship between the wireless industry and the FCC. Just as Tom Wheeler went from running the CTIA (1992– 2004) to chairing the FCC (2013–2017), Meredith Atwell Baker went from FCC commissioner (2009–2011) to the presidency of the CTIA (2014 through today). To ensure its access on Capitol Hill, the wireless industry made $26 million in campaign contributions in 2016, according to the Center for Responsive Politics, and spent $87 million on lobbying in 2017.

"Neutralizing the safety issue has been an ongoing imperative because the research keeps coming, much of it from outside the United States. But the industry's European and Asian branches have, like their US counterpart, zealously war-gamed the science, spun the news coverage, and thereby warped the public perception of their products' safety." (Underlining , italics and emphasis added.)

EXHIBIT 21B-3 (FD):
Captured Agency: How the Federal Communications Commission Is Dominated by the Industries It Presumably Regulates. Norm Alster. Harvard University Center for Ethics.
https://ethics.harvard.edu/files/center-for-ethics/files/capturedagency_alster.pdf

Reads in part:

"**Industry control, in the case of wireless health issues, extends beyond Congress and regulators to basic scientific research**. And in an obvious echo of the hardball tactics of the tobacco industry, the wireless industry has backed up its economic and political power by stonewalling on public relations and bullying potential threats into submission with its huge standing army of lawyers. In this

way, a coddled wireless industry intimidated and silenced the City of San Francisco, while running roughshod over local opponents of its expansionary infrastructure.

"On a personal level, the entire system is greased by the free flow of executive leadership between the FCC and the industries it presumably oversees. Currently presiding over the FCC is Tom Wheeler, a man who has led the two most powerful industry lobbying groups: CTIA and NCTA. It is Wheeler who once supervised a $25 million industry-funded research effort on wireless health effects. But when handpicked research leader George Carlo concluded that wireless radiation did raise the risk of brain tumors, Wheeler‘s CTIA allegedly rushed to muffle the message."

EXHIBIT 21B-4 (FD):
Doubt is Their Product: How Industry's Assault on Science Threatens Your Health. Dr. David Michaels, epidemiologist, Director, Project on Scientific Knowledge and Public Policy, former Assistant Secretary of Energy for Environment, Safety, and Health, and Professor in Environmental & Occupational Health Department, George Washington University. In 2006, Dr. Michaels received the American Association of the Advancement of Science's Scientific Freedom and Responsibility Award.

EXHIBIT 21B-5 (FD):
Disconnect: The Truth About Cell Phone Radiation, What the Industry Is Doing to Hide It, and How to Protect Your Family. Dr. Devra Lee Davis, PhD, MPH, University of Pittsburgh Professor of Epidemiology, Visiting Professor of Medicine, Hebrew University Hadassah Medical School, and President, Environmental Health Trust.

EXHIBIT 21B-6 (FD):
CBC News coverage of the tactics used by the cell phone and wireless industry to suppress the science and keep the truth about cell phones and cancer hidden. A number of scientific studies are cited that showed biological effects from cell phone radiofrequency radiation. It is also stated that the part of the Interphone Study which took into account 'heavy' users showed a doubling and even quadrupling of tumors among that group. Includes interview of Dr. Devra Davis, PhD, MPH.

EXHIBIT 21B-7 (FD):

Cellular Telephone Russian Roulette: A Historical and Scientific Perspective. Dr. Robert C. Kane, PhD, Electrical Engineering with emphasis in fields of electromagnetics and solid state physics, Illinois Institute of Technology. "As a research scientist and product design engineer, he has been directly involved with programs and projects for the design and development of portable cell phones, radio frequency mobile radios, microwave telecommunications systems, video display systems, and biological effects research." Dr. Kane was a developer for Motorola and an industry whistleblower. His monograph reads in part:

"The EMF and radiofrequency radiation issues are receiving a great deal of attention as of late. Whenever ... attention focuses on radiation from hand-held portable transmitters it invariably includes recent research findings that support the position that there may be an increased risk of disease caused by operating these devices.

"Most notably, the currently available books, and articles on the RF radiation issue give only slight consideration, if any at all, to the large body of research studies that establish the scientific foundation on which the current findings are based.

"Typically, the most recent research study will be reported as a revelation to be investigated further while industry continues to treat each such study as if it were isolated in the scientific universe. By keeping the findings uncollected and the data dissembled the financially interested parties can continue business as usual. Business [as] usual amounts to utilizing their substantial resources to employ the various media to broadcast the industry 'belief system.' The 'belief system' renounces or buries unfavorable scientific findings.

"This monograph takes a bold step backward by providing a broad view of **the scientific landscape that clearly advises us that there is danger here**. The bold step backward is a **historical accounting of the research that is available, has been available for forty years or more, and has been neglected or buried by an industry that will place its absolute need to sell products above the health and well-being of its own customers**. The practice of producing such products can only be viewed as predatory.

"Never in human history has there been such **a practice as we now encounter with the marketing and distributing of products hostile to the human biological system by an industry with *foreknowledge* of those effects**. Unlike the tobacco industry, which could claim ignorance for many decades after its product came into common use, **the telecommunications industry has had access to this same scientific research base** to which you will now be introduced.

"In this work you will not find details of the most recent research findings of cancer causation or DNA damage. Those studies, each in its turn, have been well publicized and quickly forgotten as the industry 'spin doctors' discounted the importance of each finding. Instead **what you will find here is a commentary that presents a litany of past research studies, hundreds of research studies from the 1950s through the mid-1990s. ... These older studies are equally alarming in their findings of radiation exposure, DNA damage, chromosome damage, tissue damage, radiation absorption, cataract formation, tumor formation, memory loss, motor skills degradation, and more**. There are many more studies, hundreds that might have been added, but the point is well made by those that are cited ... ."

...

"What we learn is that a **repeated insult or irritation to a particular biological area**, such as a small region of the brain, **can lead to irreparable damage**. That is, **given** the existence of **energy absorption 'hot spots,' the existence of which have been verified by numerous researchers**, **then each damaging exposure to radiofrequency radiation provides a new opportunity that the damage will become permanent. Part of the problem is that an exposed person would never know of the penetration and damage.**"

...

"The telecommunications industry would never have grown to the global force, with virtually unlimited power, that we know it to have today if it accepted the scientific research. So the industry did as has been done throughout history. **The industry developed a 'belief' system**. The wonderful thing about a 'belief' system is that it doesn't require any scientific findings. And any contrary findings that do develop are easily dismissed—as being unbelievable." (Underlining, italics and emphasis added.)

EXHIBIT 21B-8 (FD):

University of Colorado Research Biochemist and Professor of Chemistry, Dr. Jerry Phillips, PhD, comments on Motorola's efforts to suppress publication of industry-adverse research findings of positive results showing DNA damage from radiofrequency radiation.

EXHIBIT 21B-9 (FD):

Comments on the Texas Public Utility Commission Smart Meter Report.

"The report, *Health and RF EMF from Advanced Meters — An Overview of Recent Investigations and Analyses*, was entered into this docket [E-00000C-11-0328] on June 28, 2013, by Steven M. Olea, Director of the Arizona Corporation Commission's Utility Division. ...

"The Report was prepared by Alan Rivaldo, who is a staff member at the Texas Public Utility Commission, where he works on cyber security and smart grid technology issues. The Report is dated December 2012 and listed as Project No. 40190."

[Comments on Texas PUC Smart Meter Report - Begin quote]

Setting the tone

Several pages of the Report are used to discredit the opposition in a manner that is surprising for a document published by a public entity.

The theme throughout the Report is that the opposition is based on myths and hysteria, propagated by social media, and totally lacks scientific support. This is a very one-sided assessment, based on cherry-picked evidence.

The Report resorts to personal attacks on five people, including two American physicians who have voiced their objections to wireless smart meters.

The reader is informed that some vendors are selling talismans and dietary supplements with wild claims that they protect against EMF. These kinds of dubious products have appeared in response to many health problems throughout human history. As none of them are endorsed by any serious player opposing smart meters, their existence is irrelevant to this discussion. Mentioning them is simply a propagandistic effort to smear the opposition.

Some YouTube videos made by individuals are also highlighted as examples of unscientific materials. These videos are not what the concerns rest upon.

The physician William Rea testified before a committee of the Texas legislature regarding smart meters, so the Texas PUC report spends some effort to discredit him. Dr. Rea is a medical pioneer who has treated many patients with electrical hypersensitivity (EHS) and other emerging illnesses. He has helped many people and the walls of his clinic are filled with awards from many societies. The medical establishment often frowns upon the unorthodox methods of medical pioneers. The classic example is Dr. Ignaz Semmelweis, who advanced the field of hygiene (Wikipedia).

Two cases of scientific misconduct are presented. The unstated implication is that much (all?) evidence of health effects from EMF is based on fraud and unscientific methods. The reference is to a website with a dubious reputation, and the story is not as simple as presented. The case of Hugo Rüdiger is discussed at length in the book *Disconnect*, by Devra Davis, Ph.D, MPH. When the scientific journal that published Rüdiger's findings was informed about the allegations, it launched an investigation and concluded there was no fraud, and the article was not retracted.

The Rüdiger case appears to be an effort of the cell phone industry to harass and discredit a researcher who produced results damaging to these special interests. The book *Disconnect* mentions various such cases.

The Report is not above using tactics similar to what happens in some political campaigns. This is unworthy of a public institution and of a report which repeatedly paints itself as being scientific and objective.

Looking at the medical evidence

It is very conspicuous how little space is used in the Report to look at the scientific background for the concerns about wireless devices, such as smart meters. A reader who is not familiar with the literature would make the conclusion that there is none, which is very misleading.

The BioInitiative report (2007 edition) is briefly mentioned, and dismissed by citing some of the criticism of it, while not mentioning any of the positive reception it has had, such as at the Council of Europe and the European Environment Agency. The BioInitiative report (now available in the 2012 edition) is produced by a large group of independent scientists from several countries. It correlates the entire body of science on the subject of non-thermal effects of electromagnetic radiation. **To simply dismiss this body of evidence, and the thousands of studies it cites, is a clear bias**. The Report makes no attempt to look at any of the actual medical evidence. (Emphasis added.)

One-sided choice of sources

The Report places great weight on sources focused on promoting the smart grid, not sources focused on public health.

The Electric Power Research Institute (EPRI) is referred to very prominently in the Report. Its publications are cited several times and the same publications have also been the foundation of the opinions of other entities cited in the Report (such as the California Council of Science and Technology).

The author of the Report even echoes the EPRI stance that there are no long-term health effects from cell phones, contrary to that of the World Health Organization (WHO). The WHO's cancer panels are not known for their snap judgments, and should be much more qualified to make such assessments than techno-centric EPRI. However, the Report's author almost mocks the WHO evaluation of cell phones' health effects.

EPRI is portrayed as an "independent" organization with the implication that they are not beholden to special interests. The reality is that EPRI is closely aligned

with the utility industry, on which it is almost fully dependent for funding. We are not aware of any case where EPRI has published anything contrary to industry interests.

The Smart Grid Technical Advisory Project (SGTAP) is another group focused on advancing the smart grid, which carries great weight in the Report. According to SGTAP, the findings on health effects from the use of cell phones do not have any bearing on smart meters. It is true that there are important differences. A cell phone imparts a higher level of radiation, for a limited period of time, while a smart meter provides chronic radiation at a lower level. However, it is important to realize that the announcement by the World Health Organization was not limited to cell phones.

Since the issue is involuntary chronic radiation of the entire population, is it really reasonable to accept ever smaller differences, as reason to ignore the body of research? Even if presented with a large and impeccably managed epidemiological study of smart meters on real people, the industry is very unlikely to accept it. They will surely find reasons to criticize and demand more studies and more delays on any form of measures. These tactics have worked so well on other issues, of which tobacco, leaded gasoline and asbestos are just the well-known examples.

One of the very few medical sources cited is a Swedish paper, where the primary author is Anders Ahlbom. Ahlbom has been deeply involved in the issue of EMF health effects and served with ICNIRP, WHO and other entities, always promoting his view of no health effects. In 2011 it was revealed he co-owned a firm that specialized in lobbying on behalf of the cell phone industry. He was asked to step down as chairman of WHO's radio-frequency cancer board (IARC), but remains influential in the debate (Microwave News, 5/22/11).

The possible conflicts of interest in the sources prominently cited by the Report is briefly mentioned and dismissed. This is despite the large body of evidence available that this is indeed a major problem. See our April 29, 2013 filing in this docket (E-00000C-11-0328) for lists of books and peer-reviewed articles on this topic.

The opinions of several public utility commissions and other public bodies are listed in the Report. Again, their focus is not public health, and they lack medical expertise. These entities are thus likely to use the same sources, in effect creating an echo-chamber of opinion.

The logic employed in many of these reports is based on the smart meters radiating less than the FCC limits, therefore they are deemed safe. The FCC limits were set in 1996 and are based on an outdated thermal model, which much evidence shows

to be too simplistic (according to the BioInitiative report, the Council of Europe Resolution 1815, the Freiburger Appeal, the Benevento Resolution, etc.).

The Texas PUC Report refers multiple times to the obscure website www.emfandhealth.com for opinions on the medical research. This web site specializes in criticizing certain studies finding EMF health effects, but does not appear to be subject to scientific standards and review. Their tone is not exactly unbiased, either.

Radio, TV and cell towers

The Report states that they were not able to find *any* reported health complaints regarding radio and television transmitters, and little about cell towers. It speculates why it found so little opposition, since these transmitters are more powerful than wireless smart meters. The reality is very different from these speculative opinions.

These transmitters are truly much more powerful. Some large radio stations have transmitters of 100,000 watts, though they are always placed on a tall tower and generally in rural areas, so they are not close to many residences. A cell tower may transmit at 25 watts per channel, and be placed close to residences. Meanwhile, a wireless smart meter is usually placed directly on a home, with a transmitter power around 1 watt. However, the distance to the transmitter is very important, as the radiation level drops exponentially. In practice, the exposure levels are often at comparable levels from these three sources. There have been several epidemiological studies conducted on populations exposed to radio, TV and cell phone towers. **Most of them show health effects at radiation levels similar to what many people are exposed to from wireless smart meters**. We have presented some of these in our May 30, 2013 filing (ACC docket E-00000C-11-0328), and have since discovered more. (Underlining and emphasis added.)

There has in fact been opposition to various transmitters throughout the years, but they have received very little interest in the press. The grassroots organization Cellular Phone Task Force has been operating since cell towers were first put up on a large scale in the mid-1990s.

The cell phone industry was already back then sufficiently concerned about the opposition to their installations that their lobbyists had a provision put in the 1996 Telecommunications Act (section 704), which directly prohibits siting cell towers based on health complaints. This law has discouraged many community activists.

Still, there have been many attempts at opposing new towers. They could just not use the health issues as an argument before any zoning authorities. Sometimes the site owner has been convinced to not allow a tower on their property, as was the

recent case with Robins Elementary School in Tucson. With a site owner typically being paid $10,000-$15,000 a year to host a tower, it is a hard sell.

There have even been violent citizen actions against transmission towers, such as the 2010 destruction of the two KRKO AM radio towers in Snohomish Valley in Washington state. We are familiar with similar stories from Ireland, Germany and Australia.

There have been various protests, such as by the firefighters' union, claiming siting transmission towers on fire stations have made several of their members sick. British police officers have also complained about the TETRA police radio system.

The American documentary movie *Full Signal* interviews several anti-tower activists.

There is one low-radiation zone in the United States, around the town of Green Bank, West Virginia. The zone protects the nearby radio observatory from interference, and several people with severe electrical hypersensitivity have relocated there to escape radio transmitters. The story has been published in several foreign media (such as the BBC web site), but not much in the United States.

The city of Arcata, California has established a municipal code which prohibits the siting of transmission towers within 1000 ft (330 meters) of a home and 1500 ft (500 meters) from schools and hospitals (Arcata Municipal Code 9.44.060.A.3).

There are natural low-EMF zones in many rural areas that are far from any transmitters. Some people have quietly moved to these areas, as it is largely futile to fight the towers. Of course, towers are erected in rural areas as well, just at a slower pace and they are generally much more dispersed.

In Europe and elsewhere, the authorities have been more concerned about protecting the public health, especially for children. There are now restrictions on sale and advertising of cell phones in France and Belgium. Low-radiation zones with restrictions on tower sitings (which still allow cell phone use) have been established in Sweden, Austria and France.

There have been successful legal actions against transmitters, with three national Supreme Court rulings against tower operators:

- France – 2009
- Italy – 2011
- India – 2012

The Indian rulings are the most comprehensive, potentially resulting in the removal of thousands of cell towers in India's largest city of Mumbai, as well as in the state of Rajasthan (*Times of India*, 9/8/12 and 7/9/13).

There is no simple answer as to why the opposition to smart meters is more widespread than against other wireless transmitters. Some of the mechanisms have already been mentioned; another is that the people who are acutely affected are in poor health and low in numbers. They are easily ignored by the authorities. It is only when people who are *not* affected join the cause that the authorities are forced to pay attention, and it is easier to get people interested when a technology is forced upon them with little benefit. The growing awareness of the general issue is probably another factor.

Comments by academia

The Report mentions an open letter in support of smart meter technology, which is signed by 61 scientists and engineers, primarily in Quebec, Canada. Again, these are technical people, not medical professionals.

The Report fails to mention the open letter (*"Correcting the Gross Misinformation"*), which protests the Canadian open letter, and is signed by 54 scientists and physicians in the field of health effects from EMF. The letter was organized by David O. Carpenter, M.D., who is the subject of personal attacks by this Report.

There is also no mention of the Freiburger Appeal and the Benevento Resolution, which both are more general, but are applicable. They are both signed by physicians and scientists.

Electrical hypersensitivity (EHS)

The Report states:

Double-blind studies which were well-controlled and well-conducted had shown that symptoms were not correlated with EMF exposure.

It is true that the majority of the studies do not demonstrate such a correlation, but very few, if any, of the studies are well-conducted or well-controlled.

The mentioned studies at King's College were conducted in regular offices in a regular building, with several of the test subjects getting symptoms from just being in the lab.

It is very difficult to conduct such studies on EHS patients. It requires rigorous controls of the environment, which most of the studies fail to do. Common problems include the presence of computers, fluorescent lighting and other triggers. This is analogous to asking an asthmatic to discern whether there is a cigarette smoker present in a room filled with cigar smoke.

Other problems include delayed reactions. Few people with EHS react right away and sometimes have their most severe symptoms hours later. Travel to the lab may produce symptoms that first show up after entering the laboratory.

There is also the problem that symptoms rarely turn on and off on command. Instead, the EHS patients tend to get generalized symptoms after exposures, which linger long after the exposure ends. Some people experience symptoms which then disappear with further exposures as the body adapts, but with worse effects happening the following day. These mechanisms may already be at play before the experiments even start, due to the travel to the site and the ambient levels in the laboratory. It is very difficult for most people with EHS to determine exposures with the precision demanded for these tests.

Very few of the studies have attempted to separate the effects of trauma and anxiety, which are a common result of contracting EHS, as they are for other life-altering illnesses.

Many of the studies are conducted by departments which are focused on psychiatric illnesses, which may slant their conclusions. The King's College research group published a 2012 article which puts forth the absurd idea that people with EHS simply want to live as hermits (PubMed 23288087).

The Report does not mention that EHS is recognized as a legitimate illness by the Austrian Medical Association, and as a functional impairment in Sweden. the Council of Europe has also recognized EHS in its Resolution 1815.

The physical mechanism for EHS is presently not understood. This is normal for a new syndrome, and does not mean EHS is not "legitimate". Many other diseases of the past half century were not well understood either in the beginning, such as AIDS, asbestosis, allergies and asthma. Autism and fibromyalgia are still not understood. Much is still to be learned about most of these illnesses.

General acceptance of an illness takes time, especially when it conflicts with established dogma and special interests. Meanwhile, those who are sick are subjected to the ridicule of which this Report is a mild example. With very little funding available to investigate an illness that is not "legitimate", the prospect for proving its existence scientifically is very long. AIDS became accepted as "real"

once the Hollywood actor Rock Hudson contracted it. Do we have to wait for such a lucky break?

Conclusion

The Report's cover letter to the Texas PUC states that the report is *"intended to objectively address the issue."* Unfortunately, **the Report cannot be considered objective, as it has a strong bias in its content, language and choice of sources**. (Emphasis added.)

The theme throughout the Report is that there are no legitimate concerns of any kind and the public discussion is simply a matter of science versus myth and hysteria. That the concerns of the public are simply an artifact of social media with no basis in reality.

The Report barely mentions the concerns raised by the scientific community, and instead resorts to personal attacks on some of them. **None of the scientific findings upon which these concerns are based are addressed**. **No primary sources are used. Instead, the Report bases its conclusions almost exclusively on the opinions of techno-centric entities, which are not focused on the public health**. **Particular weight is given to the opinions of organizations with a focus on promoting smart grid technologies and other conflicts of interest**. (Emphasis added.)

The central topic of the Texas PUC report is a health issue, but the author has an educational background in engineering and business administration, with expertise in cybersecurity and smart grid technologies. He does not appear to have any medical training.

If physicians started to publicly voice their opinions on whether specific bridges or buildings are structurally sound or not, engineers would probably not find that appropriate. So why does this report almost exclusively rely on the opinions of engineers, physicists and utility-funded institutes to say with great confidence that there are no health effects from radio-frequency radiation?

The Texas Public Utility Commission would have been much better served if this Report was prepared by someone with a proper background and no strong pre-set opinions on this topic.

This Report is neither objective nor scientific, and is of limited value to a balanced debate. Some opponents to smart meters have certainly **produced what amounts to propaganda**, and so have some utilities, but **one should not expect that from a governmental agency, funded by taxpayer money**. (Emphasis added.)

[Comments on Texas PUC Smart Meter Report - End quote]

EXHIBIT 21B-10 (FD):
The Real Junk Science of EMFs. Microwave News, November 23, 2009 issue. Reads in part:

"[Leeka] Kheifets and Swanson's paper is worse than junk science, it's fraud. The paper seeks to give the electric industry a major prize by taking electric fields off the EMF health agenda. This is, by any reasonable definition, scientific misconduct, and is far more serious than any of the cases that have been pursued by those who police scientific integrity (see "Three Cases of Alleged Scientific Misconduct").

"Far from ever being challenged, Kheifets has been and continues to be in great demand. She has helped shape every major EMF risk evaluation in recent memory. Swanson has been invited to attend many of the same meetings.

"ICNIRP, which touts itself as being free of industry ties, has had Kheifets on its Standing Committee on Epidemiology for the last seven years. The committee publishes influential literature reviews on health risks, including the possible links between power lines and cancer.

"Back in 2001, IARC, the International Agency for Research on Cancer, though fully aware that Kheifets worked for EPRI, invited her to sit on its committee evaluating EMF cancer risks as a full voting member. IARC also welcomed Swanson to sit in as an observer. According to those who were at the meeting, Swanson participated in the deliberations no differently that he would have as a member of the committee.

"Soon afterwards Kheifets joined Mike Repacholi at WHO's EMF Project in Geneva. EPRI continued to support her while she was at the WHO, even though this was in apparent violation of WHO rules governing conflicts of interest ... ."

EXHIBIT 21B-11 (FD):
Time to Stop the WHO [EMF] Charade. Microwave News, Vol. XXV No. 3, June-December 2005. Reads in part:

"Now we know what Mike Repacholi has been doing since the infamous Mike-and-Leeka flip-flop of 2003. Back then Repacholi and his assistant Leeka Kheifets decided that there was no need to apply the precautionary principle to EMFs—soon after telling everyone that the time for action had finally arrived.

"It appears that for the last two-and-a-half years, when not shuttling from one meeting to another, Mike has been cataloguing ways the WHO can avoid taking precautionary steps to reduce EMF exposures."

...

"Back in early 2003, there were enough reasons to invoke the precautionary principle for power-frequency EMFs and for RF from mobile phones. Over the last year, more studies have reaffirmed the need for caution. Three different data sets now implicate long-term use of mobile phones with acoustic tumors: Two from the Öreboro group and one from the Karolinska group. The University of Vienna has found support for Henry Lai and NP Singh's studies showing that RF radiation can break DNA—these results from the REFLEX research program indicate that RF radiation may well be genotoxic after all. And even more recently, an Australian researcher reported additional evidence that RF can break up DNA."

...

"When the REFLEX DNA work first hit the media, Mays Swicord ... at Motorola didn't have to say a word because their man in Geneva, Mike Repacholi of the World Health Organization, was ready to speak for them. Mike offered immediate reassurances that the Vienna results are spurious and may be discounted. 'One has to question what went wrong, or was different, for them to get the results they claim,' Mike told the *New Scientist*."

EXHIBIT 21B-12 (FD):

"Radiation Research" and The Cult of Negative Results: A Microwave News Investigation. Microwave News, Vol. XXVI No. 4, July 31, 2006. Reads in part:

"*Radiation Research* is a scientific journal whose primary focus is on ionizing radiation, with only a minority of papers devoted to the non-ionizing side of the electromagnetic spectrum. Its June issue, however, features five papers, all of which claim to show that EMFs of one type or another have no biological effects.

"To account for this departure from the norm, Sara Rockwell, the editor-in chief, Bruce Kimler, an associate editor, and John Moulder, a senior editor, have offered an apologia, under the title, "Publishing Negative Results." (In this context, "negative results" refers to studies that show no effects.) The editors want you to believe that they are offering this bumper crop of negative papers as a public service. They are on a mission, they say, to allay "widespread concern" over power lines and cell phones by giving a voice to those who, despite great effort, could not substantiate previously reported findings of 'deleterious health effects.'

"The editorial tacitly concedes that *Radiation Research* only rarely publishes papers showing any type of EMF effects by failing to cite a single example from its

own pages. At the same time, it fails to mention that other journals, for instance *Mutation Research* and *Bioelectromagnetics*, have had no trouble finding high-quality papers with "positive" results —that is, those that *do* show biological effects.

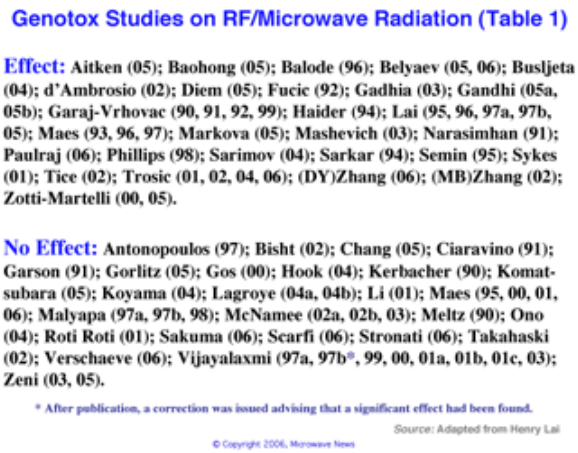
"Many of the negative EMF studies that have been published in *Radiation Research* were paid for by industry ... which seek to control EMF research (often by stopping it) and to show that microwaves are essentially harmless except at high exposure levels. Promoting no-effect studies has long been part of their strategy to keep a lid on the microwave-health controversy.

"**Wireless companies like Motorola have fostered** the **spurious view that negative studies cancel out positive ones**. Their strategy is this: First, seed the journals with no-effect papers that run counter to previously published work which does show biological changes. Then argue: 'If we couldn't replicate the effect, it cannot be real.' The assumption here is that industry science is superior to everyone else's. They make no effort to resolve inconsistent results. (Underlining and emphasis added.)

"Another important fact goes undisclosed in the editorial: One of its authors, John Moulder ... has a lucrative consulting practice on EMFs and health. Over the years, Moulder has earned hundreds of thousands of dollars disputing the existence of adverse EMF health effects, even those accepted by most other members of the EMF community.

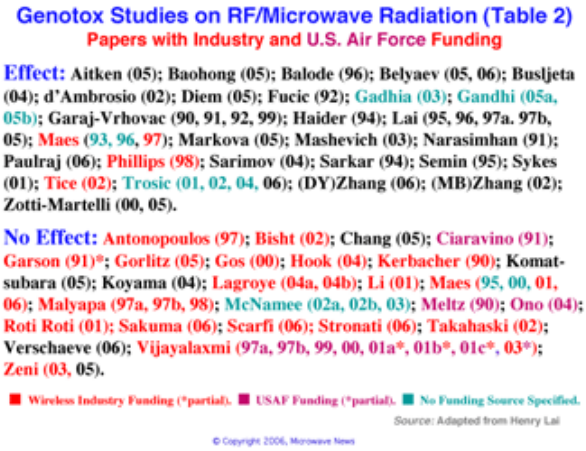
"To explore the potential biases at work, *Microwave News* investigated a subset of health studies published in peer-reviewed scientific journals. We selected papers on microwave-induced genotoxicity; that is, microwave effects on DNA, the genetic blueprint inside every living cell. With the generous help of Henry Lai of the University of Washington, Seattle, we identified 85 radiofrequency (RF)/microwave-genotox papers published since 1990. Of these, 43 found some type of biological effect and 42 did not.

"Lai is an interested party to this controversy. Together with N.P. Singh, Lai made RF/microwave genotoxicity a major concern when, in the mid-1990's, they were the first to report that microwaves could lead to DNA single- and double-strand breaks. As you can see in Table 1, Lai is the lead author of four of the 43 'effect' or positive studies.



[Click on each table to download a pdf]

"There is just about an even split between effect and no-effect papers. But look what happens when we superimpose the funding source for each study (where available): Those sponsored by industry are in red and those sponsored by the U.S. Air Force are in purple in Table 2. (Papers with no declared funding source are in green.)



"A clear —and disconcerting— pattern emerges: 32 of the 35 studies that were paid for by the mobile phone industry and the U.S. Air Force show no effect. They make up more than 75% of all the negative studies. You don't need to be a statistician to infer that money, more often than not, secures the desired scientific result.

"One of the three industry studies that did find an effect nearly failed to make it into print. It was carried out by Jerry Phillips under a Motorola contract. Motorola opposed Phillips' decision to write up his positive findings and, according to Phillips, the company tried to stop him. Phillips resisted and succeeded, but it was the last piece of original EMF research he ever completed.

"A similar loss of balance occurs when you look at only the papers published in *Radiation Research.* These are colored orange in Table 3.

Genotox Studies on RF/Microwave Radiation (Table 3)
Papers Published *in Radiation Research*

Effect: Aitken (05); Baohong (05); Balode (96); Belyaev (05, 06); Busljeta (04); d'Ambrosio (02); Diem (05); Fucic (92); Gadhia (03); Gandhi (05a, 05b); Garaj-Vrhovac (90, 91, 92, 99); Haider (94); Lai (95, 96, 97a, 97b, 05); Maes (93, 96, 97); Markova (05); Mashevich (03); Narasimhan (91); Paulraj (06); Phillips (98); Sarimov (04); Sarkar (94); Semin (95); Sykes (01); Tice (02); Trosic (01, 02, 04, 06); (DY)Zhang (06); (MB)Zhang (02); Zotti-Martelli (00, 05).

No Effect: Antonopoulos (97); Bisht (02); Chang (05); Ciaravino (91); Garson (91); Gorlitz (05); Gos (00); Hook (04); Kerbacher (90); Komatsubara (05); Koyama (04); Lagroye (04a, 04b); Li (01); Maes (95, 00, 01, 06); Malyapa (97a, 97b, 98); McNamee (02a, 02b, 03); Meltz (90); Ono (04); Roti Roti (01); Sakuma (06); Scarfi (06); Stronati (06); Takahaski (02); Verschaeve (06); Vijayalaxmi (97a, 97b, 99, 00, 01a, 01b, 01c, 03); Zeni (03, 05).

■ Published in *Radiation Research.*

Source: Adapted from Henry Lai

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"Over the last 16 years, only one positive paper on microwave genotoxicity has appeared in *Radiation Research.* During the same time, the journal has published 21 negative genotox papers. (Australia's Pam Sykes, the lead author of the lone positive paper, was denied money for a follow-up and soon moved on to other research areas.)

"When Tables 2 and 3 are combined, you can see that 80% of the negative papers (17 out of 21) published in *Radiation Research* were paid for by either industry or the U.S. Air Force. These are in red in Table 4.

Genotox Studies on RF/Microwave Radiation (Table 4)
***Radiation Research* Papers Sponsored by Industry and/or USAF**

Effect: Aitken (05); Baohong (05); Balode (96); Belyaev (05, 06); Busljeta (04); d'Ambrosio (02); Diem (05); Fucic (92); Gadhia (03); Gandhi (05a, 05b); Garaj-Vrhovac (90, 91, 92, 99); Haider (94); Lai (95, 96, 97a, 97b, 05); Maes (93, 96, 97); Markova (05); Mashevich (03); Narasimhan (91); Paulraj (06); Phillips (98); Sarimov (04); Sarkar (94); Semin (95); Sykes (01); Tice (02); Trosic (01, 02, 04, 06); (DY)Zhang (06); (MB)Zhang (02); Zotti-Martelli (00, 05).

No Effect: Antonopoulos (97); Bisht (02); Chang (05); Ciaravino (91); Garson (91); Gorlitz (05); Gos (00); Hook (04); Kerbacher (90); Komatsubara (05); Koyama (04); Lagroye (04a, 04b); Li (01); Maes (95, 00, 01, 06); Malyapa (97a, 97b, 98); McNamee (02a, 02b, 03); Meltz (90); Ono (04); Roti Roti (01); Sakuma (06); Scarfi (06); Stronati (06); Takahaski (02); Verschaeve (06); Vijayalaxmi (97a, 97b, 99, 00, 01a, 01b, 01c, 03); Zeni (03, 05).

■ Published in *Radiation Research* and supported by industry and/or the U.S. Air Force.

Source: Adapted from Henry Lai

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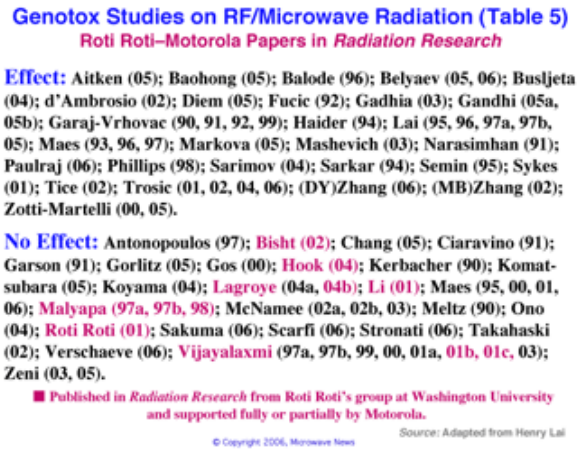
"And of these 17, most are associated with a single lab: Joe Roti Roti's at Washington University in St. Louis. Roti Roti's principal funding source is Motorola. The 10 Roti Roti–Motorola papers on RF/microwave genotoxicity are in pink in Table 5.



"In addition, many other Roti Roti papers on other types of microwave effects, also paid for by Motorola, have been published in *Radiation Research.* With respect to microwave radiation, it almost appears as if *Radiation Research* is a house organ of the Motorola Corporation."

...

"Back in 2001 after Moulder had moved up to senior editor, he recruited Vijayalaxmi of the University of Texas in San Antonio to join the *Radiation Research* editorial board. A couple of years earlier they, together with some colleagues from Washington University and the U.S. Air Force, had published a review paper that dismissed any possible connection between cell phones and cancer. This too was published in *Radiation Research.*

"As shown in Table 2, Vijayalaxmi is the lead author on seven of the microwave-genotox papers. All were funded by the U.S. Air Force, Motorola or a combination of the two.

"Last year, while she was still an associate editor at *Radiation Research* (she stepped down soon afterwards), Vijayalaxmi together with Sheila Johnston, a long-time consultant to the mobile phone industry based in London, launched an aggressive assault against Lai and Singh and their work on genotoxicity. In an e-mail accompanying their analysis of Lai–Singh's research, Johnston wrote: 'Lai's science has failed CONCLUSIVELY' [her emphasis]. The Vijayalaxmi–Johnston rant was so amateurishly written that it was largely ignored. What's harder to forget is the virulence of their attack. 'They are not scientific statements,' Singh told us at the time, 'they are personal attacks. They do not want to solve problems, they want to eliminate us.'"

...

"At a time when potential conflicts of interest among authors of medical and scientific papers are front page news (see, for instance, the July 11, 2006 *Wall Street Journal* on a paper published by the *Journal of the American Medical Association),* and more and more journals are requiring full disclosure of ties to

industry, it is surprising —no, astonishing— that a leading radiation journal allows such obvious conflicts to remain unacknowledged. An editorial in the Sunday *New York Times* on July 23, said that the 'best hope' for the credibility of medical journals is for them "to try much harder to find authors free of conflicts."

EXHIBIT 21B-13 (FD):
Industry Funding Bias and Conflict of Interest in Research on the Biological Effects of Exposure to Electromagnetic Radiation and Other Biomedical Research. Entered as Item 465, MPUC Docket 20011-0062. Compilation listing additional articles and reports which illustrate the effects that industry funding of research and widespread conflicts of interest have on the biasing of scientific study results concerning biological and health effects of EMFs and RF radiation. The obvious advantage to the wireless industry of playing the 'weight-of-evidence' game, that is, of making believe that the credibility or reliability of results of positive studies can be cancelled simply by producing a greater number of studies having inconclusive (negative) results, is brought further into perspective.

The wireless industry has not funded safety studies out of altruism or concern for the public, but out of self-interest. Put simply, the industry spends money certainly not to lose money, but to ensure its making even more. To the industry, safety studies are strictly a business investment. They are simply a cost of doing business while enabling the industry to protect its lucrative commercial interests behind a facade of negative, cherry-picked studies and a bogus interpretation of 'weight of evidence'. Any claim by industry that wireless technology is safe on such a basis is, of necessity, scientifically indefensible and completely unjustified, and the 'safety' of which industry so illegitimately and perversely assures is inauthentic, illusive, and ultimately false.

Nonetheless, because studies showing adverse biological effects potentially can have a significant, negative impact upon industry profits, the industry's money and influence largely have been focused on funding studies principally for the purpose of using them to cancel positive study results. This warped, deeply flawed, entirely anti-scientific strategy of persuading regulators and policy makers can and will continue only for as long as industry can get away with camouflaging the fallacy of reducing 'weight of evidence' to a simple, crude tally approach to assessing the body of available scientific evidence.

Accordingly, in addition to scrutinizing funding and conflicts of interest that have infested the field of research into the safety of wireless technologies, it is incumbent upon regulators and policy makers to closely examine the relative strength and quality of the evidence rather than merely keep count of the number of

studies with negative versus positive results. It should always be kept in mind that **the evidence obtained from a single, technically and meticulously well-designed, positive study is scientifically stronger and more reliable than the results of any number of negative studies that are not as carefully designed**.

By and large, positive results of studies are not replicated not because such results are inherently not replicable or reproducible, but because of the general, often intentional failure to faithfully replicate the ***design*** and protocols set and followed in the original studies.

Contrary to what PPL apparently would have this Court believe, negative studies do not, because they cannot, legitimately cancel or negate well-designed, positive studies on a simple, one-to-one basis. 'Weight of evidence', as it is routinely interpreted and applied by industry, therefore does not directly translate to, and of itself does **not** establish, 'preponderance of evidence'.

EXHIBIT 21B-17 (FD):
Lecture at the Edmond J. Safra Center for Ethics of the Harvard Law School presented by Dr. Franz Adlkofer, MD, entitled: *The exposure limits supposed to protect people from radiofrequency radiation are the result of institutional corruption*. November 3, 2011. Extended March 16, 2012. Two of Dr. Adlkofer's research studies that showed DNA breakage resulting from exposure to radiofrequency radiation were alleged by the wireless industry to be fraudulent, and Dr. Adlkofer was charged with professional misconduct. After years of investigation, his research results held up to scientific scrutiny, and he finally was exonerated. His Harvard lecture reads in part:

"According to the IARC panel the results of epidemiological studies had been decisive for the 'possibly carcinogenic' classification. These studies observed after long-term (>10 years) and intensive use of cell phones an increased risk for brain tumors exactly at the side of the head at which the cell phone was held. The results from animal experiments, although of minor significance, supported the decision. **Yet, results from basic research like REFLEX that showed changes in structure and functions of genes in isolated human and animal cells as well as in living animals after exposure and that would have provided weight to the epidemiological observations were not taken into account**. **Had they been included, the classification would not have been 'possibly carcinogenic' but rather 'probably carcinogenic'**. However, it was obviously not the intention of the IARC, an organization of the WHO, to confront politics and industry that had expected a classification of 'not classifiable' with such a harsh decision. (Emphasis added.)

"The new classification is a warning shot for **the wireless communication industry** as well as for the many governments on its side. Quite obviously their **strongholds, i.e. the national and international committees that they have filled with hired scientists in the course of decades in order to protect their interests** have been heavily damaged." (Emphasis added.)

...

"Investigations generously financed by the industry and allegedly carried out with an improved methodology usually end with a negative outcome. If the results are threatening the safety concept by attacking the exposure limits as in the case of the REFLEX data the industry obviously does not shy away from public campaigns directed against the unwanted findings and their authors. **The means are always the same: accusations of fraud and personal defamations of the authors**. **The U.S. wireless communication industry has coined the term *war gaming* for such exceptional cases**." (Emphasis added.)

...

"**The biggest dilemma is the fact that efforts by politics and industry of hiding the truth, even supported by most of the media, are successful**. **The general public has either no idea of the probably adverse effects of radiofrequency radiation or has full confidence in exposure limits that according to their governments reliably protect them**. Of course, people understandably prefer to distrust those scientists who caution against probable risks to their health, especially when their professional and moral reputation has been damaged through institutional corruption. Smear campaigns like the ones by Lerchl have certainly left their marks. The results of basic research and epidemiological studies have widely been ignored by the public, although they jointly indicate a significantly increased brain tumor risk in users of cell phones for more than ten years. With at present 5 billion cell phone users worldwide a human catastrophe is probably already under way. In democracies, it is a basic principle that above power and their owners are laws, rules, and regulations to which the owners of the power have to bow. History teaches that early warnings are far too often followed by late insights for which many people have to pay with disease and premature death. **As shown here, these rules and regulations are at present trampled underfoot by those responsible for radiation protection** ..." (Emphasis added.)

...

It is in the interest of a democratic society that it is fully informed about what is going on behind the political curtain, no matter what consequences they will draw.

EXHIBIT 21B-18 (FD):

Wi-Fried: Children and Wireless Devices. Australian ABC TV report by Dr. Maryanne Damasi. In this excerpt from the report, Frank Clegg, former CEO Microsoft Canada, comments on the machinations of the wireless industry. Mr. Clegg states in part:

"I've been in the industry all my career, and I've seen the tremendous benefits that technology can provide. My concern is: nobody can say that it's safe. **All my industry and all government agencies say is there's no proof of harm, and** to my mind, **that's not the same as saying it's safe**.

"Unfortunately, the safety standards in North America and Australia are based on this theory that's many decades old -- that if tissue doesn't get heated, then it can't cause harm. And that's just out of date. And what the biologists tell us and have shown in many, many experiments and again, peer-reviewed, published papers, that there is damage done at the DNA level, and from a biological standpoint, is non-thermal radiation can cause, and does cause, harm to humans.

"Any government agency, in my opinion, that has done a review in the last two or three years, and hasn't made a significant change to their safety standard, has not done a proper and thorough review of the science. ... If you can't say it's safe, then you be cautious how you use it.

"I am embarrassed to say that **I believe my industry is on a campaign to bury the science and to confuse the message on the harmful effects of wireless devices**.

EXHIBIT 21C-1 (FD):
The Cell Phone War: Dr. George Carlo vs. The Wireless Phone Industry. Dr. George L. Carlo, PhD, JD, Epidemiologist & Public Health Scientist, former Chairman, 'Wireless Technology Research' (WTR) (1990–96), and Chairman, Public Policy Institute, Washington, DC. Dr. Carlo, the cell phone industries' 'Wireless Technology Research' former chief scientist—turned whistleblower—exposes industry spin and outright fraud concerning safety of cell phone radiofrequency radiation. Quoting Dr. Carlo:

"Almost every study that has been done shows some evidence of danger. Now the other side of the coin here is that there are *no studies* that have been done on people who use mobile phones *that provide conclusive evidence of safety*. So that on the human epidemiology side, you have studies that show problems or potential problems and studies that are inconclusive. Now the industry spins the science, and they put it out there for public consumption as though these studies are evidence of safety. It is scientific fraud."

EXHIBIT 21C-2 (FD):
Cell phones, safety, and spin. ABC 20/20 report. Several independent scientists repudiate claims made by the wireless phone industry trade group's then-president,

Thomas Wheeler, who stated the following blatant falsehood: "[T]here is nothing that has come up in the research that suggests there is a linkage between the use of a wireless phone and a health effect." (This person later became head of the FCC, exemplifying the pervasiveness of 'regulatory capture' by special interests.)

EXHIBIT 29C-16 (FD):
Smart Meters: Correcting the Gross Misinformation. Article published by ***La Maison du 21e siecle***, dated June 11, 2012.
https://ecfsapi.fcc.gov/file/7521097472.pdf and
https://maisonsaine.ca/actualites/smart-meters-correcting-the-gross-misinformation.html

Reads in part:

[Correcting the Gross Misinformation - Begin quote]

Quebec-based magazine La Maison du 21e siecle asked physician David O. Carpenter, former founding dean of the University at Albany (NY)'s School of Public Health, to comment an open letter published in the Montreal daily Le Devoir last May 24. This letter claimed wireless smart meters pose no risk to public health. More than fifty international experts contributed to the following rebuttal. (Underlining added.)

We, the undersigned are a group of scientists and health professionals who together have coauthored hundreds of peer-reviewed studies on the health effects of electromagnetic fields (EMFs). We wish to correct some of the gross misinformation found in the letter regarding wireless "smart" meters that was published in the Montreal daily *Le Devoir* on May 24. Submitted by a group Quebec engineers, physicists and chemists, the letter in question reflects an obvious lack of understanding of the science behind the health impacts of the radiofrequency (RF)/microwave EMFs emitted by these meters.

The statement that « Thousands of studies, both epidemiological and experimental in humans, show no increase in cancer cases as a result of exposure to radio waves of low intensity… » is false (1). In fact, only a few such studies — two dozen case-control studies of mobile phone use, certainly not thousands, have reported no elevations of cancer, and most were funded by the wireless industry. In addition, these reassuring studies contained significant experimental design flaws, mainly the fact that the populations followed were too small and were followed for a too short period of time. (Underlining and emphasis added.)

Non industry-funded studies have clearly demonstrated a significant increase in cancer cases among individuals who have suffered from prolonged exposure to low-level microwaves, transmitted notably by radio antennas. The effects were best documented in meta-analyses that have been published and that include grouped results from several different studies: these analyses consistently showed an increased risk of brain cancer among regular users of a cell phone who have been exposed to microwaves for at least ten years.

...

Well-known bioeffects

While the specific pathways to cancer are not fully understood, it is scientifically unacceptable to deny the weight of the evidence regarding the increase in cancer cases in humans that are exposed to high levels of RF/microwave radiation.

The statement that « there is no established mechanism by which a radio wave could induce an adverse effect on human tissue other than by heating » is incorrect, and reflects a lack of awareness and understanding of the scientific literature on the subject. In fact, more than a thousand studies done on low intensity, high frequency, non-ionizing radiation, going back at least fifty years, show that some biological mechanisms of effect do not involve heat. This radiation sends signals to living tissue that stimulate biochemical changes, which can generate various symptoms and may lead to diseases such as cancer.

Even though RF/microwaves don't have the energy to directly break chemical bonds, unlike ionizing radiation such as X-rays, there is scientific evidence that this energy can cause DNA damage indirectly leading to cancer by a combination of biological effects. Recent publications have documented the generation of free radicals, increased permeability of the blood brain barrier allowing potentially toxic chemicals to enter the brain, induction of genes, as well as altered electrical and metabolic activity in human brains upon application of cell phone RF/microwaves similar to those produced by smart meters.

These effects are cumulative and depend on many factors including RF/microwave levels, frequency, waveform, exposure time, biovariability between individuals and combination with other toxic agents. Clear evidence that these microwaves are indeed bioactive has been shown by the fact that low-intensity EMFs have proven clinically useful in some circumstances. Pulsed EMFs have long been used to successfully treat bone fractures that are resistant to other forms of therapy. More recently, frequency-specific, amplitude-modulated EMFs have been found useful to treat advanced carcinoma and chronic pain. (Emphasis added.)

High frequency EMFs such as the microwaves used in cell phones, smart meters, Wi-Fi and cordless ‘‘DECT’’ phones, appear to be the most damaging when used

commonly. **Most of their biological effects, including symptoms of electrohypersensitivity, can be seen in the damage done to cellular membranes by the loss of structurally-important calcium ions. Prolonged exposure to these high frequencies may eventually lead to cellular malfunction and death**. (Emphasis added.)

...

Smart meters

As Australian Associate Professor of neurosurgery Vini G. Khurana reports, adverse neurological effects have been reported in people who sustain close proximity to wireless meters, especially under 10 feet (3 metres).

A wireless smart meter produces radiofrequency microwave radiation with two antennas in approximately the same frequency range (900 MHz to 2.4 GHz) as a typical cell tower. But, depending on how close it is to occupied space within a home, a smart meter can cause much higher RF exposures than cell towers commonly do. If a smart meter is located on a common wall with a bedroom or kitchen rather than a garage wall, for example, the RF exposure can be the same as being within 200 to 600 feet distance of a cell tower with multiple carriers. **With both cell towers and smart meters, the entire body is immersed by microwaves that go out in all directions, which increases the risk of overexposure to many sensitive organs such as the eyes and testicles.** With a cell phone, people are exposed to microwaves primarily in the head and neck (unless using speaker mode), and only when they use their device. (Emphasis added.)

Wireless smart meters typically produce atypical, relatively potent and very short pulsed RF/microwaves whose biological effects have never been fully tested. They emit these millisecond-long RF bursts on average 9,600 times a day with a maximum of 190,000 daily transmissions and a **peak level emission two and a half times higher than the stated safety signal, as the California utility Pacific Gas & Electric recognized before that State's Public Utilities Commission. Thus people in proximity to a smart meter are at risk of significantly greater aggregate of RF/microwave exposure than with a cell phone**, not to mention the cumulative exposure received by people living near multiple meters mounted together, pole-mounted routers or utility collector meters using a third antenna to relay RF signals from 500 to 5,000 homes. (Emphasis added.)

A technical study performed by Sage Associates in California indicates that RF levels from various scenarios depicting normal smart meter installation and operation may violate even the out-of-date US public safety standards which only consider acute thermal effects. This can happen when a person stands close to the meter to read the power consumption, or touches it, or shades the meter face with a hand to better read it. Emissions are also increased by reflective materials, such as

stainless steel, other metals and mirrors, which can re-radiate stronger that the otherwise unaltered background. Microwaves are absorbed and dissipated by partially conductive materials, such as cement and special RF shielding paints and fabrics.

In addition to the erratic bursts of modulated microwaves emitted by wireless smart meters ... are also a major source of ‘‘dirty electricity’’ (electrical interference of high frequency voltage transients typically of kilohertz frequencies). Some scientists, such as American epidemiologist Sam Milham, believe that many of the health complaints about smart meters may also be caused by **dirty electricity generated by the « switching » power supply activating all smart meters**.

...

1. Scientific papers on EMF health effects
2. Explanation and studies on electrosensitivity
3. Governments and organizations that ban or warn against wireless technology

• David O. Carpenter, MD, Director, Institute for Health & the Environment, University at Albany, USA

- Franz Adlkofer, M.D., Chairman of the Pandora Foundation, Coordinator of the European Reflex Report on DNA-damage by cellphone radiation, Neuendorf, Germany

• M. S. H. Al Salameh, PhD, Professor of Electrical Engineering, University of Science & Technology, Irbid, Jordan

• Jennifer Armstrong, MD, Past President, American Society for Environmental Medicine, Founder, Ottawa Environmental Health Clinic, Ontario, Canada

• Pierre L. Auger, MD, Occupational medicine, Multiclinique des accidentés 1464, Montreal, Quebec, Canada

• Igor Beliaev, PhD, Head research scientist, Cancer Research Institute, Slovak Academy of Sciences, Bratislava, Slovak republic

• Fiorella Belpoggi, PhD, Director Cesare Maltoni Cancer Research Center, Ramazzini Institute, Bologna, Italy

• Dominique Belpomme, MD, Director of the European Cancer and Environment Research Institute, Brussels, Belgium

• Martin Blank, PhD, former President, Bioelectromagnetics Society, Special Lecturer, Department of Physiology and Cellular Biophysics, Columbia University Medical Center, New York, USA

• Barry Breger, MD, Centre d’intégration somatosophique (orthomolecular medicine), Montreal, Quebec

• Simona Carrubba, PhD, Prof. Biophysics, Daemen College, Amherst, NY, Associate Researcher, Neurology, Buffalo General Hospital , Buffalo, NY

• John Cline, MD, Professor, Institute for Functional Medicine, Federal Way, WA, USA, Medical Director, Cline Medical Centre, Nanaimo, BC, Canada

• Alvaro Augusto de Salles, PhD, Professor of Electrical Engineering, Federal University of Rio Grande do Sul, Porto Alegre, Brazil
• Christos Georgiou, Prof. Biochemistry, Biology Department, University of Patras, Greece
• Andrew Goldsworthy, PhD, Honorary lecturer in Biology, Imperial College, London, UK
• Claudio Gómez-Perretta, MD, Director, Centro de Investigación, Hospital Universitario LA Fe, Valencia, Spain
• Livio Giuliani, PhD, Senior Researcher, National Insurance Institute (INAIL), Chief of Radiation and Ultrasounds Research Unit, Rome, Italy
• Yury Grigoriev, PhD, Chair Russian National Committee on Non-Ionizing Radiation Protection, Moscow, Russia
• Settimio Grimaldi, PhD, Director, Institute of Translational Pharmacology (Neurobiology and molecular medicine), National Research Council, Rome, Italy
• Magda Havas, PhD, Centre for Health Studies, Trent University, Canada
• Lennart Hardell, MD, Professor of Oncology, University Hospital, Örebro, Sweden
• Denis L. Henshaw, PhD, Professor of Physics, Head of The Human Radiation Effects Group, University of Bristol, UK
• Ronald B. Herberman, MD, Chairman of Board, Environmental Health Trust, and Founding Director emeritus, University of Pittsburgh Cancer Institute, USA
• Donald Hillman, PhD, Dairy Science, Professor Emeritus, Department of Animal Science, Michigan State University, USA
• Isaac Jamieson, PhD, Environmental Science (electromagnetic phenomena in the built environment), independent architect, scientist and environmental consultant, Hertfordshire, UK
• Olle Johansson, PhD, Professor of Neuroscience (Experimental Dermatology Unit), Karolinska Institute, Stockholm, Sweden
• Yury Kronn, PhD, Soviet authority on physics of nonlinear vibrations and high frequency electromagnetic vibrations, founder of Energy Tools International, Oregon, USA
• Vini G. Khurana, MBBS, Associate of Professor of Neurosurgery, Australian National University, Australia
• Henry Lai, PhD, Professor of Bioengineering, University of Washington School of Medicine, Seattle, WA, USA
• Abraham R. Liboff, PhD, Professor Emeritus, Department of Physics, Oakland University, Rochester, Michigan, USA
• Don Maisch, PhD, Researcher on radiation exposure standards for telecommunications frequency, EMFacts Consultancy, Tasmania, Australia
• Erica Mallery-Blythe, MD, Emergency Medicine Physician, England
• Andrew A. Marino, PhD, Professor of Neurology, LSU Health Sciences Center, Shreveport, LA, USA
• Karl Maret, MD, President, Dove Health Alliance, Aptos, CA, USA

• Fiorenzo Marinelli, PhD, Researcher on biological effects of EMFs, Institute of Molecular Genetics, National Research Council, Bologna, Italy
• Andrew Michrowski, PhD, Director, Planetary Association for Clean Energy, Ottawa, Canada
• Sam Milham, MD, former chief epidemiologist, Washington State Department of Health, USA
• Joel M. Moskowitz, PhD, Director, Center for Family and Community Health, School of Public Health, University of California, Berkeley
• Gerd Oberfeld, MD, Public Health Department, Salzburg State Government, Austria
• Mike O'Carroll, PhD, Professor Emeritus (Applied Mathematics), University of Sunderland, UK
• Jerry L. Phillips, PhD, Director, Center for Excellence in Science, Department of Chemistry and Biochemistry, University of Colorado, USA
• John Podd, PhD, Professor of Psychology (experimental neuropsychology), Massey University, New-Zealand
• William J. Rea, MD, thoracic and cardiovascular surgeon, founder of the Environmental Health Center, Dallas, Tx, USA
• Elihu D. Richter, MD, Professor, Hebrew University-Hadassah School of Public Health and Community Medicine, Jerusalem, Israel
• Leif G. Salford, MD, Senior Professor of Neurosurgery, Lund University, Sweden
• Nesrin Seyhan, MD, Founder and Chair of Biophysics, Medical Faculty of Gazi University, Turkey
• Cyril W. Smith, PhD, lead author of "Electromagnetic Man", retired from Electronic and Electrical Engineering, University of Salford, UK
• Morando Soffritti, MD, Scientific Director of the European Foundation for Oncology and Environmental Sciences "B. Ramazzini" in Bologna, Italy
• Carlos Sosa, MD, surgeon affected by the Microwave syndrome, Medellin, Columbia
• Antoinette "Toni" Stein, PhD, Collaborative on Health and the Environment (CHE-EMF Working Group), Co-Coordinator, Berkeley, CA, USA
• Stanislaw Szmigielski, MD, PhD Professor of Pathophysiology, Consulting Expert, former director of Microwave Safety, Military Institute of Hygiene and Epidemiology, Warsaw, Poland
• Lauraine Vivian, PhD, Senior Lecturer, Primary Health Care Directorate, Faculty of Health Sciences, University of Cape Town, South Africa.
• Bradford S. Weeks, MD, Director, The Weeks Clinic, Clinton, WA, USA
• Stelios A. Zinelis, MD, Vice-President, Hellenic Cancer Society, Cefallonia, Greece

[Correcting the Gross Misinformation - End quote]

EXHIBIT 36B (FD):
BioInitiative Working Group review of the SCENIHR *Preliminary Opinion on Potential Health Effects of Exposure to Electromagnetic Fields (EMF*) dated November 29, 2013. Critiques in detail the many striking errors, omissions and inadequacies of the SCENIHR's *Preliminary Opinion*. A number of these omissions and inadequacies are so glaring that it would be appropriate either to suspect a high level of bias among its members, or to call into question their scientific professionalism, or both. Reads in part:

"**All of these comments and criticisms argue most strongly for a conclusion in the SCENIHR Final Opinion on EMF that health effects are possible, and in some cases such effects are established."**

10. Exhibits of Documentary Films Explicating Issues Surrounding Exposure to Radiofrequency Radiation Emitted by Wireless Devices Including AMI Smart Meters

This section includes the following:

Exhibit Nos. 21M, 21N, 21O, 21P, and 21Q.

All of the exhibits listed within this section constitute directly relevant and credible evidence of reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

EXHIBIT 21M (FD):
Maine Supreme Judicial Court interrogation of attorney representing the Maine Public Utilities Commission concerning the Maine PUC's failure to require an electric utility to conduct RF safety testing on smart meter facilities prior to permitting deployment of the smart meter devices and technology. These circumstances in Maine mirror those in Pennsylvania in this regard, except that the Maine PUC had provided customers a voluntary opt-out of smart meter installation.

EXHIBIT 21N (FD):
Mobilize: A Film About Cell Phone Radiation (documentary).

EXHIBIT 21O (FD):
Take Back Your Power. Documentary film focusing on privacy, health and safety issues specifically concerning wireless smart meters.

EXHIBIT 21P (FD):
Generation Zapped. Documentary film explicating issues surrounding wireless RF radiation and the hazards it poses especially to children and future generations.

EXHIBIT 21Q (FD):
Full Signal. A 2010 documentary film on issues pertaining to the ubiquitous proliferation of RF-radiating wireless technologies and the challenges they pose to government regulators and health agencies with respect to the manifestly inadequate protections provided by present public policy.

B. Safety: Risk of AMI Smart Meter explosions and fires

1. Exhibits and Partial Transcripts Concerning Substantially Increased Risk of AMI Smart Meter Explosions and Fires

This section includes the following:

Exhibit Nos. 46A through 46T, especially Exhibits 46A, 46B-1, 46C, 46D, 46E, 46F, 46G, 46H-1, 46H-2, 46H-3, 46I-1, 46I-2, 46I-3, 46J-1, 46J-2, 46J-3, 46J-4, 46K, 46L-1, 46L-2, 46L-3, 46L-5, and 46T.

All of the exhibits listed within this section constitute directly relevant and credible evidence of reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

Explication and justification of the evidentiary exhibits in this section is given full relevance within the context of the Complainants' assertions of fact.

As the evidence included in **EXHIBITS 46A through 46S** clearly shows, there have been numerous explosions of AMI smart meters directly resulting from their considerably greater vulnerability to electrical power surges. There also have been numerous building fires, many of which likely have resulted from overburdening of existing electrical wiring by conducted emissions produced by wireless smart meters at the circuit or load panel. The electric utility companies naturally seek to place the blame for smart meter fires on any factor(s) other than the smart meters themselves. It is important to note, however, that there are **multiple reasons**, other than worn or faulty meter sockets or improper installation, as to why smart meters can and do overheat and catch fire. AMI wireless smart meters, constructed with

plastic and fiberglass digital circuit boards, are less capable than earth-grounded, metal-and-glass, electromechanical analog meters to withstand electrical power surges without arcing, overheating, melting, exploding or bursting into flames.

"PPL argues that the new AMI meters are not a fire hazard because they are equipped with software and mechanisms that better alert the Company if there is an issue with overheating. ... In the instant case, PPL showed that there is a heat alarm set within the meter software program, so when the temperature of the meter hits an established level, the Company is alerted of the issue. Tr. 247. Further, PPL takes 15-minute interval temperature readings from the meter, so it can track the meter's temperature, PPL will dispatch a technician to investigate. Tr. 247-248. Thus, as PPL's expert witness Dr. Davis stated, 'the smart meters can actually help people from having a fire' because of the temperature alarms. Tr. 283-284." (*Alan V. Schmukler v. PPL Electric Utilities Corporation*.)

Such reasoning naïvely places an unwarranted degree of trust and overreliance upon hardware-software interface technology which too easily could have occasion to fail due to any of a number or combination of unanticipated conditions and contingencies. Needless to say, to think that a technician could be dispatched in time to prevent sudden meter explosions and fires caused by electrical power surges is ludicrous and absurd. Moreover, even in cases of sockets and circuits overheating at the meter site, the length of time required by the utility to fully respond, once a problem is recognized, very often could be too long to prevent a fire from spontaneously occurring. The question therefore should have been raised as to whether such heat alarm software should, could or would have made any difference in the litany of smart meter explosions and fires referenced by exhibits which follow.

Most basic is the fact that a meter is only as safe as its weakest link. Heat alarm software simply cannot make up for the fact that *all* AMI smart meters come with profound weaknesses, as described below. The very fact that wireless smart meters, which are built on plastic and fiberglass electronic circuit boards, need to be equipped with heat sensors is indicative that these devices are inherently more vulnerable and prone to overheating and catching fire than standard electromechanical analog meters.

EXHIBITS 46A through 46S (FD):
Documented, visual *evidence of multiple fires and* ***simultaneous explosions*** of wireless smart meters, including meters manufactured by **Landis+Gyr**. PPL Electric Utilities has deployed, and is deploying, meters manufactured by Landis+Gyr.

AMI smart meters are markedly inferior to standard analog meters in terms of their material construction and surge protection capability. AMI smart meters differ from analog meters in that smart meters are not equipped with spark gap surge protectors which divert power surges to ground. ***This fact alone means that smart meters are substantially less capable than analog meters of safely withstanding electrical power surges***.

EXHIBIT 46A (FD):
Power surge raises questions about SmartMeters: East Palo Alto electricity surge burnt out digital meters. News article reported in *Palo Alto Weekly* concerning 80 smart meters which caught fire and burned due to an electrical power surge. A Palo Alto spokesperson is quoted as saying that **"surges have not burned out the city's analog meters."** The article identified **Landis+Gyr** as the manufacturer of the meters.

EXHIBIT 46B-1 (FD):
Surge Blows Smart Meters, Leaves Neighbourhood Without Hydro. The Forest Standard, November 7, 2013. Newspaper article reporting that between 60 and 70 smart meters were blown out simultaneously by an electrical power surge. Some of the meters caught fire. The article identified **Landis+Gyr** as the manufacturer of the meters.

EXHIBIT 46C (FD):
CBS affiliate news report of series of smart meter explosions after truck causes electrical power surge.

EXHIBIT 46D (FD):
Wireless Smart Meters and Potential for Electrical Fires. Sage Associates and James J. Biergiel, EMF Electrical Consultant. Provides a very fundamental, important reason as to how and why conducted emissions produced and propagated by smart meters can render homes and buildings more vulnerable to electrical fires: "**Typical gauge electrical wiring that provides electricity to buildings (60 Hz power) is not constructed or intended to carry high frequency harmonics** that are increasingly present on normal electrical wiring. ... ***The use of smart meters will place an entirely new*** *and* **significantly increased burden** ***on existing electrical wiring*** because of the very short, very high intensity wireless emissions (radio frequency bursts) that the meters produce to signal the utility about energy usage. ... The **RF emissions from any smart meter in the main panel might trigger an electrical fire at *any* location in the building** served by this main panel

because harmonics can and will travel anywhere on electrical wiring of that building." (Underlining, italics and emphasis added.)

According to The EMR Policy Institute, "[C]omponents of Smart Meters are out of compliance with the National Electric Code (NEC) because they trip the Ground Fault Interrupters and Arc Fault Interrupters, creating a fire hazard. …Un-intentional re-radiation of RF/MW signal (with its higher energy) on the electrical wires may overload wires, particularly in poorly grounded or ungrounded homes, or homes with
older wiring or faulty wiring."

EXHIBIT 46E (FD):
National Labor Relations Board court proceeding (Cases 16-CA-103387 and 16-CA-112404) involving **Landis+Gyr smart meter fires**. Pages 17 and 18 read in part:

"**Despite Its Representations, ... Respondent was Confronted with Smart Meter Problems, Including Fires and Lawsuits**

"**[T]he record is replete with evidence concerning smart meter safety issues**. ... Respondent was confronted with various smart meter problems, including installation problems and lawsuits filed alleging fires starting as a result of smart meters." ...

"Respondent and Landis+Gyr, the manufacturer of the smart meters used by Respondent, entered into a settlement agreement with the State Farm Lloyds Insurance Company on November 8, 2013, concerning the aforementioned July 7, 2011, fire at the Chaney residence (GC Exh. 6, 8). **The ALJ correctly found that, 'presumably, the problem arose with the smart meter itself' because Landis+Gyr indemnified Respondent**. (JD slip op. at 17, LL. 7-9).

"Respondent's Associated General Counsel Stewart acknowledged that around October 2012, one of the Respondent's litigators, Dan Altman, told him that there were two or three lawsuits alleging that smart meters were responsible for causing fires. (JD slip op. at 17, LL. 4-7; Tr. 1609, 1615-16, 1619 passim). Two of them were ultimately settled. (JD slip op. at 17, L. 7; Tr. 1616, LL. 8-17)." (Underlining and emphasis added.)

EXHIBIT 46F (FD):
ABC affiliate news report on lawsuits that claim faulty smart meters started house fires.

EXHIBIT 46G (FD):
NBC affiliate news report on investigation sparked by rash of smart meter fires. Images of **Landis+Gyr Focus AXR** smart meters are displayed.

EXHIBIT 46H-1 (FD):
Associated Press report: Nevada fire chiefs seek probe of ‘smart’ meters they believe to be associated with a string of fires.

EXHIBIT 46H-2 (FD):
Reno Gazette-Journal report: *Fire chiefs call for smart meter probe after blazes*. One fatality and one case of burn injury resulted from these fires involving smart meters. According to the utility's vice president, the company to date had responded to 70 "consumed meters" which have had their plastic casings "melted or breached." Article reads in part:

"The forensic investigator that examined the Rhinestone Circle smart meter also examined three more smart meters associated with fires in Reno and Sparks. He found evidence that each of the three meters—one from Reno on Arletta Drive and two from Sparks—failed.

"'It is probable the Arletta meter did fail, resulting in the ignition of the fire,' Thoresen wrote."
...
[Sparks Fire Chief Tom] "Garrison said meter fires are particularly concerning because they start on the outside of the house, won't be picked up by indoor smoke detectors and can escape immediate notice.

"'It can burn a long time and enter the attic or the walls,' Garrison said. 'The occupants inside may not even be aware the house is on fire. This is very alarming ... .'"

EXHIBIT 46H-3 (FD):
Oregonian news report: Portland General Electric, *PGE replacing 70,000 electricity meters because of fire risk*. Article reads in part:

"**Reports of smart meter malfunctions, explosions and fires**, meanwhile, **have cropped up around the country and the world** ... ." ...

"SaskPower, a utility in Saskatchewan, Canada, is in the midst of a province-wide smart meter program using Sensus meters. But it suspended that initiative two weeks ago following **six fires tied to meters in the last two months**." (Underlining and emphasis added.)

EXHIBIT 46I-1 (FD):
NBC10 Philadelphia news report: *"New 'Smart Meters' Can Overheat, Cause Fires"*. *"PECO to replace new technology because utility says new meters can overheat if hooked up to existing wiring that isn't up to date"*.

EXHIBIT 46I-2 (FD):
NBC10 News Philadelphia (Sep. 12, 2012) report - *Fire Officials: Home Scorched by PECO "Smart Meter." PECO confirms 26 incidents of smart meters overheating*.

EXHIBIT 46I-3 (FD):
WCAU NBC 10 Philadelphia news report: Smart meter fires in Bucks County, PA increase number of reported PECO smart meter fires to total of 29 as of September, 2012.

PECO was to have completed the company's replacement of Sensus smart meters by October 2012. The company claims to have had no more problems with smart meter fires since switching to **Landis+Gyr** meters.

"[T]hese Sensus AMI meters were eventually removed by PECO and replaced with Landis + Gyr Focus AXR-SD meters, the same as are being deployed at residences by PPL through its Agent Grid One Solutions." (*Alan V. Schmukler v. PPL Electric Utilities Corporation*.)

"In the *Frompovich* case, the Commission recognized PECO Energy Company (PECO) did have an issue with the initial deployment of Sensus smart meters. The Commission held:

...in approximately 2012, **those meters were all removed and replaced with the Landis + Gyr Focus meters.** PECO showed that since the installation of over 1.2 million of Landis + Gyr Focus meters, **there have been no reports of fire incidents related to the meters**." (*Alan V. Schmukler v. PPL Electric Utilities Corporation*.) (Underlining and emphasis added.)

Notwithstanding, another smart meter fire occurred in Tredyffrin Township on February 27, 2013.

EXHIBIT 46J-1 (FD):
Tredyffrin Township Public Meeting Minutes, March 18, 2013.
"Assistant Fire Chief, Eamon Brazunas, Berwyn Fire Company, reported that there were 27 fire calls ... He reported on two significant incidents, one which may have been caused by sparking and arcing around the Smart-Meter installed by PECO."

EXHIBIT 46J-2 (FD):
Peco pushing its smart meters ...Some have raised questions about fire risks. TruEnergy, March 17, 2013.
"Peco spokeswoman Liz Williamson acknowledged Friday that a **Feb. 27 fire** on Knox Road in Tredyffrin Township ***occurred a few hours after the utility installed one of its new meters***." (Underlining and italics added.)

On February 6, 2014, another smart meter fire occurred at an apartment complex in Bensalem, Bucks County, PA:

EXHIBIT 46J-3 (FD):
Electric meter blamed for Bensalem apartment fire. Bucks County Courier Times, Feb. 7, 2014. According to Bensalem Battalion Chief, Robert Sponheimer, the fire "started in a utility meter in an outside shed that housed electrical meters ... ."

In testimony given at a Pennsylvania House Majority Policy Committee hearing held on April 14, 2014, it was stated that: "Smart Meter fires continue even with the installation of the new **Landis meter**. ... **The meter itself is the cause of the Bensalem fire, not the arcing and not the wires** per the Bensalem Fire Marshal." (Emphasis added.)

EXHIBIT 46J-4 (FD):
Camera footage of smart meter fire at apartment building in Bensalem, PA, Feb. 6, 2014. The manufacturer of the smart meter involved in the fire is **Landis+Gyr**.

As these fires occurred in the **Landis+Gyr** replacement meters—a fact which **directly contradicts** the claim that "**there have been no reports of fire incidents related to the meters**" since the installation by PECO of Landis+Gyr Focus

meters—it is certainly apparent that the touted "heat alarm software" made no difference in those cases.

EXHIBIT 46K (FD):
Homeowner liable for damage after smart meter catches fire. Green Bank City News.

Quite informative is the direct testimony of electrical engineer, William S. Bathgate, before the Michigan Public Service Commission (**EXHIBIT 46L-2**). In a separate letter (**EXHIBIT 46L-1**), Mr. Bathgate has stated:

EXHIBIT 46L-1 (FD):
"UL 2735 compliance is not the same as UL 2735 Listed. ... **Landis+Gyr AMI meters** are built to UL 2735 *but they* **are not UL tested**. What this deception means is that they can tell you they are UL 2735 compliant, because the components *individually* are sourced from manufacturers that have obtained UL Listed status. ... **There have been numerous Landis+Gyr meters explode and catch fire and they are stated as meeting UL 2735**." (Underlining, italics and emphasis added.)

EXHIBIT 46L-2 (FD):
In his detailed testimony before the Michigan Public Service Commission, Mr. Bathgate explained what are ***very likely the fundamental causes of the numerous smart meter explosions and fires that have occurred and why these dangers are likely to continue***:

"The customers with smart meters have increased risk of fires, electrical medical equipment damage and appliance damage occurring due to the AMI Meters design creating EMI/RFI effects commonly called conducted emissions and also called EMC. See **Exhibit RCG-05** (WSB-05) A portion of the customers have concerns relating to the operation of the AMI Meters and the resulting electromagnetic infiltration of their homes from Electro-Magnetic and Radio Frequency Interference generated within the unfiltered AMI Meter Switched Mode Power Supply (SMPS) ... The SMPS circuit board has very limited surge protection resulting from incoming voltage transients. The main component on the SMPS that is vulnerable is called a Varistor, which looks like a small black square on the SMPS board. See **Exhibit RCG-06** (WSB-06). This small electronic part cannot withstand more than a 300 Volts AC surge. The part will explode when a line voltage surge exceeds this limit, such as when a tree branch touches the high

voltage lines or lightning strike occurs nearby. Once this Varistor explosion has occurred it permits high voltage transfer to the other circuit board components and the circuit board substrate. This results in the AMI meter literally exploding from the meter socket or in a severe melting of the plastic components, likely leading to a fire and/or severe home damage. Most customers that comment when this occurs say they hear a load pop or a boom, followed by lights flickering, and followed by arcing at the meter housing. This is not how a circuit board should be protected. In series with the Varistor should be a small fuse that would stop voltage progression to the remaining circuit components and interconnections. Every SMPS in the home from a vast array of electronic appliances has a Varistor, such as TV's, PC power supplies, electronically controlled refrigerators, washers, dryers and heating/cooling systems but also has a fuse or fuse-able link that will break the circuit before catastrophic damage progressively results from a surge. There is no sound electronic engineering firm that would permit 240 volts AC to short circuit across the circuit boards due to a component failure such as a Varistor. This is extremely dangerous. Once the progression of the subsequent short circuit begins the line transformer will apply up to 2,000 Amps to the meter housing until either the feed lines to the home disintegrate and vaporize or the transformer line breaker/fuse trips out after 50 seconds. By this time the damage is so extensive it is jeopardizing human and animal life. No such condition is possible from an Analog Meter. In fact the occurrence of an Analog Meter fire is almost unheard of. There are also unseen dangers from the meter to meter box contacts. ... **The AMI Meter Switched Mode Power Supply (SMPS) design is lacking what is called a differential voltage and common mode current filter circuit to keep it from back-feeding high frequency voltage transients and magnetic currents as an electrical by-product onto the home primary wiring circuits**. See **Exhibit RCG-03** (WSB-03) and **Exhibit RCG-05** (WSB-05). The result is magnetic fields and *high frequency radio emissions surrounding every room*. This class of emissions is called EMI/RFI (commonly called EMC) and is viewed by the FCC as Conducted Emissions." (MPSC U-18255-0224) (Underlining, italics and emphasis added.)

EXHIBIT 46L-3 FD:
***Evaluation of the Landis+Gyr AMI Meter*.** William S. Bathgate, EE, ME. Includes graphics and reads in part:

"The image in red is for both AMI meters (with the radios on or off) and the various forms of 'Electronic Meters.' They are not compliant to FCC rules for 'conducted' Emissions Class A or Class B. Shown here are the limits for **CONDUCTED emissions** not Radio Emissions, which is a different specification, which **are being fed back into the home wiring at the load panel**. **This is placing stress on all electronics and electric motors in the home**, causing early

appliance motor failures, appliance electronic control failures and radio interference, in addition to health effects ... ." (p. 22.) (Underlining added.)

"The biggest weakness is in the power disconnect, it suffers from a small surface area for the disconnect contact and would be prone to excessive heating and likely result in contact pitting and carbon deposits that are not readily visible by the customer and there is not a sensory circuit that could detect it and report it to the consumer or the utility. **This design would be prone to creating unpredicted fires**. (p. 26.) (Underlining added.)

"The second weakness ... is the lack of a common mode and differential filtering of the SMPS oscillations being injected from the meter onto the house wiring circuit, thus making the whole house into an antenna with dangerous RFI/EMI. ... There are ways to design a SMPS without these filters but that design would need to have a solid ground reference to earth, but **this meter design and construction does not permit an earth ground** so this scenario is unfeasible." (p. 26.) (Underlining added.)

"The fact that there is a set of circuit boards in a power meter at all is a large risk; **the circuit boards would not be able to withstand a lightning strike or a power surge** without an **explosive** reaction and likely melting of the circuits. This would lead to total destruction of the unit and lead to a possible fire." (p. 27.) (Underlining and emphasis added.)

"The AMI meter does not have a connection to ground and therefore cannot be made safe to meet the FCC Conductive Emissions Standard." (p. 37.) (Underlining added.)

EXHIBIT 46L-5 (FD):
The Landis+Gyr Smart Meter: An Inside View. Analysis prepared by Dan Mattson, EMF Technician. Page 5 reads in part:

"The surge protector components in the smart meter are very ordinary and protect only the circuit board.
I found **no evidence of surge protection that protects the electrical system the meter is connected to**.

"240 volts AC powers the electronics in this meter. **Within the meter there is no connection to the neutral. The electronics are not grounded**." (Underlining and emphasis added.)

The electric utilities industry characteristically has blamed faulty or 'hot' sockets for a large percentage of electrical fires involving wireless smart meters. The following exhibit, **EXHIBIT 46T**, further substantiates the assertion that AMI wireless smart meters, being solid-state meters which are less able to withstand hot sockets, are inherently more susceptible to fires and therefore pose greater danger to the public at large.

EXHIBIT 46T (FD):
Hot Socket Issues: Causes and Best Practices (Edison Electric Institute, TESCO) Slide presentation for which **Landis+Gyr** sponsored much of the research. Contains the following statements:

"**Electromechanical meters withstand hot sockets better than solid state meters**" (Slide 7.)

"At the start of our laboratory investigation the **oldest electro mechanical meters withstood hot sockets the best**" (Slide 17.)

"The **latest vintage solid state meters withstood hot sockets the least**." (Slide 17.)

C. Right to Reasonable Expectation of Privacy and Freedom From Unreasonable—And From Warrantless—Searches and Electronic Surveillance

This section includes the following:

Exhibit Nos. 51A, 51B, 51C, 51D, 51E, 51F, 51G, 51H, 51I, 51J, 51K, 51L, 51M-1, 51M-2, 51N, 51O, 51P, 51Q-1, 51Q-2, 51Q-3, 51Q-4, 51R, 51S, 51T, 51U, 51V, 51W, 51X-1, 51X-2, 51Y-1, 51Y-2, 51Y-3, 51Y-4, 51Z-1, 51Z-2, 51Z-3, 46L-6, 52, and 50I.

All of the exhibits listed within this section constitute directly relevant and credible evidence of reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

Explication and justification of the evidentiary exhibits in this section is given full relevance within the context of matters of law and the Complainants' assertions of fact.

In *Kyllo v. United States*, 533 U.S. 27 (2001) (**EXHIBIT 51A**), the Supreme Court held:

[Kyllo v. United States - Begin quote]

"At the very core" of the Fourth Amendment "stands the right of a man to retreat into his own home and there be free from unreasonable governmental intrusion." *Silverman* v. *United States*, 365 U.S. 505, 511 (1961). **With few exceptions, the question whether a warrantless search of a home is reasonable and hence constitutional must be answered no.** See *Illinois* v. *Rodriguez*, 497 U.S. 177, 181 (1990); *Payton* v. *New York*, 445 U.S. 573, 586 (1980).

...

See, *e.g.*, *Goldman* v. *United States*, 316 U.S. 129, 134—136 (1942); *Olmstead* v. *United States*, 277 U.S. 438, 464—466 (1928). Cf. *Silverman* v. *United States*, *supra*, at 510—512 (technical trespass not necessary **for** Fourth Amendment **violation**; **it suffices if there is "actual intrusion into a constitutionally protected area**").

...

[I]n the case of the search of the interior of homes–the prototypical and hence most commonly litigated area of protected privacy–there is a ready criterion, with roots deep in the common law, of the minimal expectation of privacy that *exists*, and that is acknowledged to be *reasonable*. ... **We think that obtaining by sense-enhancing technology any information regarding the interior of the home that could not otherwise have been obtained without physical "intrusion into a constitutionally protected area**," *Silverman*, 365 U.S., at 512, **constitutes a search**–at least where (as here) the technology in question is not in general public use. This assures preservation of that degree of privacy against government that existed when the Fourth Amendment was adopted.

...

... We rejected such a mechanical interpretation of the Fourth Amendment in *Katz*, where the eavesdropping device picked up only sound waves that reached the exterior of the phone booth. Reversing that approach **would leave the homeowner at the mercy of advancing technology**–including imaging technology that could discern all human activity in the home. While the technology used in the present case was relatively crude, **the rule we adopt must take account of more sophisticated systems that are already in use or in development**.3 The dissent's reliance on the distinction between "off-the-wall" and "through-the-wall" observation is entirely incompatible with the dissent's belief, which we discuss below, that **thermal-imaging observations of the intimate details of a home are impermissible**. The most sophisticated thermal imaging devices continue to measure heat "off-the-wall" rather than "through-the-wall"; the dissent's disapproval of those more sophisticated thermal-imaging devices, see *post*, at 10, is an acknowledgement that there is no substance to this distinction. As for the dissent's **extraordinary assertion that anything learned through "an inference" cannot be a search, see *post*, at 4—5, that would validate even the "through-the-wall" technologies that the dissent purports to disapprove**. Surely the

dissent does not believe that the through-the-wall radar or ultrasound technology produces an 8-by-10 Kodak glossy that needs no analysis (*i.e.*, the making of inferences). And, of course, **the novel proposition that inference insulates a search is blatantly contrary to *United States* v. *Karo***, 468 U.S. 705 (1984), where the police "inferred" from the activation of a beeper that a certain can of ether was in the home. The police activity was held to be a search, and the search was held unlawful.4

... **The Fourth Amendment's protection of the home has never been tied to measurement of the quality or quantity of information obtained**. In *Silverman*, for example, we made clear that any physical invasion of the structure of the home, "by even a fraction of an inch," was too much, 365 U.S., at 512 ... . In the home, our cases show, ***all* details are intimate details**, because the entire area is held safe from prying government eyes.

...

We have said that **the Fourth Amendment draws "a firm line at the entrance to the house**," *Payton*, 445 U.S., at 590. **That line, we think, must be not only firm but also bright–which requires clear specification of those methods of surveillance that require a warrant**. While it is certainly possible to conclude from the videotape of the thermal imaging that occurred in this case that no "significant" compromise of the homeowner's privacy has occurred, we must take the long view, from the original meaning of the Fourth Amendment forward.

"**The Fourth Amendment is to be construed in the light of what was deemed an unreasonable search and seizure when it was adopted, and in a manner which will conserve public interests as well as the interests and rights of individual citizens**." *Carroll* v. *United States*, 267 U.S. 132, 149 (1925).

Where, as here, the Government **uses a device that is not in general public use, to explore details of the home that would previously have been unknowable without physical intrusion, the surveillance is a "search" and is *presumptively unreasonable without a warrant***.

[Kyllo v. United States - End quote] (Underlining, italics and emphasis added.)

"Kyllo soundly reaffirmed the sanctity of the home and the Court's view that an expectation of privacy in activities taking place inside the home is presumptively reasonable." (Lerner, J. I. & Mulligan, D. K., *Taking the "Long View" on the Fourth Amendment: Stored Records and the Sanctity of the Home*, 2008 STANFORD TECHNOLOGY LAW REV. 3, ¶ 3.) (**EXHIBIT 51B**.)

Respondent, PPL, purports that its collection of customers' data through the use of smart meter technology does not infringe upon their right to a reasonable expectation of privacy and to freedom from unreasonable, warrantless searches. To

support this claim, PPL cites *Naperville Smart Meter Awareness v. City of Naperville*, 900 F.3d 521, 527-29 (7th Cir. 2018). (**EXHIBIT 51C**.)

Following the Supreme Court's guidance principally under *Kyllo*, the 7th Circuit Court of Appeals held:

[Naperville - Begin quote]

A. ***The collection of smart-meter data at fifteen-minute intervals constitutes a search.***

"At the [Fourth Amendment's] very core stands the right of a man to retreat into his own home and there be free from unreasonable government intrusion." *Silverman v. United States*, 365 U.S. 505, 511 (1961). This protection, though previously tied to common-law trespass, now encompasses searches of the home made possible by ever-more sophisticated technology. *Kyllo v. United States*, 533 U.S. 27, 31–32 (2001). Any other rule would "erode the privacy guaranteed by the Fourth Amendment." *Id*. at 34.

"Where … the Government uses a device that is not in general public use, to explore details of the home that would previously have been unknowable without physical intrusion, the surveillance is a 'search.'" *Id*. at 40. This protection remains in force even when the enhancements do not allow the government to literally peer into the home. In *Kyllo*, for instance, the intrusion by way of thermal imaging was relatively crude—it showed that "the roof over the garage and a side wall of [a] home were relatively hot compared to the rest of the home and substantially warmer than neighboring homes in the triplex." *Id*. at 30. The device "did not show any people or activity within the walls of the structure" nor could it "penetrate walls or windows to reveal conversations or human activities." *Id* (quoting Supp.App. to Pet. for Cert. 39–40). Nevertheless, the Supreme Court held that law enforcement had searched the home when they collected thermal images. *Id*. at 40.

The technology-assisted data collection that Smart Meter Awareness alleges here is at least as rich as that found to be a search in *Kyllo*. Indeed, the group alleges that energy-consumption data collected at fifteen-minute intervals reveals when people are home, when people are away, when people sleep and eat, what types of appliances are in the home, and when those appliances are used.[5] (R. 102-1 at 14.) By contrast, *Kyllo* merely revealed that something in the home was emitting a large amount of energy (in the form of heat).

It's true that observers of smart-meter data must make some inferences to conclude, for instance, that an occupant is showering, or eating, or sleeping. But ***Kyllo***

rejected the "extraordinary assertion that anything learned through 'an inference' cannot be a search." *Id*. at 36 (quoting *id*. at 44 (Stevens, J., dissenting)). **What's more, the data collected by Naperville can be used to draw the exact inference that troubled the Court in *Kyllo***. There, law enforcement "concluded that [a home's occupant] was using halide lights to grow marijuana in his house" based on an excessive amount of energy coming from the home. *Id*. at 30. Here too, law enforcement could conclude that an occupant was using grow lights from incredibly high meter readings, particularly if the power was drawn at odd hours. **In fact, the data collected by Naperville could prove even more intrusive**. By analyzing the energy consumption of a home over time in concert with appliance load profiles for grow lights, Naperville law enforcement could "conclude" that a resident was using the lights with more confidence than those using thermal imaging could ever hope for. With little effort, they could conduct this analysis for many homes over many years.

Under *Kyllo*, however, even an extremely invasive technology can evade the warrant requirement if it is "in general public use." *Id.* at 40. While more and more energy providers are encouraging (or in this case forcing) their customers to permit the installation of smart meters, the meters are not yet so pervasive that they fall into this class. To be sure, the exact contours of this qualifier are unclear—since *Kyllo,* the Supreme Court has offered little guidance. But *Kyllo* itself suggests that the use of technology is not a search when the technology is both widely available and routinely used by the general public. *See id.* at 39 n.6 (quoting *California v. Ciraolo*, 476 U.S. 207, 215 (1986) ("In an age where private and commercial flight in the public airways is routine, it is unreasonable for respondent to expect that his marijuana plants were constitutionally protected from being observed with the naked eye from an altitude of 1,000 feet.")). Smart meters, by contrast, have been adopted only by a portion of a highly specialized industry.

The ever-accelerating pace of technological development carries serious privacy implications. Smart meters are no exception. **Their data, even when collected at fifteen-minute intervals, reveals details about the home that would be otherwise unavailable to government officials with a physical search. Naperville therefore "searches" its residents' homes when it collects this data**.

Before continuing, we address one wrinkle to the search analysis. Naperville argues that the third-party doctrine renders the Fourth Amendment's protections irrelevant here. Under that doctrine, a person surrenders her expectation of privacy in information by voluntarily sharing it with a third party. *See Carpenter v. United States*, 138 S. Ct. 2206, 2216 (2018) (citing *Smith v. Maryland*, 442 U.S. 735, 743–744 (1979) and *United States v. Miller*, 425 U.S. 435, 443 (1976)). Thus, when a government authority gathers the information from the third party, it does not run afoul of the Fourth Amendment. *Id*. Referencing this doctrine, Naperville argues that

its citizens sacrifice their expectation of privacy in smart-meter data by entering into a "voluntary relationship" to purchase electricity from the city.

This argument is unpersuasive. As a threshold matter, Smart Meter Awareness challenges the collection of the data by Naperville's public utility. There is no third party involved in the exchange.[6] Moreover, were we to assume that Naperville's public utility was a third party, the doctrine would still provide Naperville no refuge. The third-party doctrine rests on "the notion that an individual has a reduced expectation of privacy in information knowingly shared with another." *Carpenter*, 138 S. Ct. at 2219. **But in this context, a choice to share data imposed by fiat is no choice at all**. If a person does not—in any meaningful sense—"voluntarily 'assume the risk' of turning over a comprehensive dossier of physical movements" by choosing to use a cell phone, *Carpenter*, 138 S. Ct. at 2220 (quoting *Smith*, 442 U.S. at 745), **it also goes that a home occupant does not assume the risk of near constant monitoring by choosing to have electricity in her home**. We therefore doubt that *Smith* and *Miller* extend this far.

...

Naperville's amended "Smart Grid Customer Bill of Rights" clarifies that the city's public utility will not provide customer data to third parties, including law enforcement, without a warrant or court order.

...

We caution, ... that our holding depends on the particular circumstances of this case. **Were a city to collect the data at shorter intervals, our conclusion could change**. Likewise, our conclusion might change if the data was more easily accessible to law enforcement or other city officials outside the utility.

...

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.

[Naperville - End quote] (Underlining and emphasis added.)

The question ought not to be what risks an individual presumably accepts by providing information to third parties, but what risks an individual "should be forced to assume in a free and open society." *Smith v. Maryland*, 442 U.S. 735 at 750 (1979) (Marshall, J., dissenting).

"The Fourth Amendment protects the individual's privacy in a variety of settings. In none is the zone of privacy more clearly defined than when bounded by the unambiguous physical dimensions of an individual's home -- a zone that finds its roots in clear and specific constitutional terms: 'The right of the people to be secure

in their ... houses ... shall not be violated.'" *Payton v. New York*, 445 U.S. 573, 589.

"The State's interest in protecting the well-being, tranquility, and privacy of the home is certainly of the highest order in a free and civilized society." *Frisby v. Schultz*, 487 U.S. 474, 484 (1988) (quoting *Carey v. Brown*, 447 U.S. 455, 471 (1980)).

"[I]t is beyond dispute that the home is entitled to special protection as the center of the private lives of our people. Security of the home must be guarded by law in a world where privacy is diminished by enhanced surveillance and sophisticated communication systems." *Minnesota v. Carter*, 525 U.S. 83, 99 (1998) (Kennedy, J., concurring).

1. In whatever matters directly pertain to our persons, our houses, our property, and our personal effects, we, as citizens of this state and of the United States, have a "reasonable expectation of privacy" as provided under Pennsylvania Common Law, the Pennsylvania Constitution, and the Constitution of the United States.

2. The Fourth Amendment **prohibits the government from intruding** into an area in which a person has an actual expectation of privacy that society would consider reasonable. *Katz v. United States*, 389 U.S. 347, 361 (1967).

3. "At the very core [of the Fourth Amendment] stands the right of a man to retreat into his own home and there be free from unreasonable government intrusion." *Silverman v. United States*, 365 U.S. 505, 511 (1961).

4. "[P]rivate residences are places in which the individual normally expects privacy free of governmental **intrusion not authorized by a warrant**, and that expectation is plainly one that society is prepared to recognize as justifiable." *United States v. Karo*, 468 U.S. at 714 (1984).

5. *Kyllo* and *Karo* demonstrate that the Supreme Court "has defended the home as a sacred site at the 'core of the Fourth Amendment.'" (95 CORNELL LAW REV. 905, 913 (2010), citing Wilson v. Layne, 526 U.S. 603, 612 (1999).)

6. The Court in *Naperville Smart Meter Awareness v. City of Naperville* held that the city's **collection of customer data with the use of smart meter technology clearly constituted a search under the Fourth Amendment**.

7. Although the Court in *Naperville* also found that the municipality's 'search' was reasonable, **it explicitly cautioned that its holding depended "on the particular circumstances of this case**." (Underlining and emphasis added.)

8. In reaching its opinion, the Court in *Naperville* took into account the following facts:

1) Naperville's utility, which is publicly-owned, had adopted a clarifying "Smart Grid Customer Bill of Rights" policy pledging that **customers' data will *not* be provided to third parties, including law enforcement, without a warrant or court order**; and

2) The collection interval of customer data by the use of smart meters in that case was **not less than fifteen minutes**.

9. The Court also asserted that its "**conclusion might change if the data was more easily accessible** to law enforcement or other city officials **outside the utility**."

10. The Court in *Naperville* additionally admonished, "**Were a city to collect the data at shorter intervals, [its] conclusion could change**."

11. The Pennsylvania Public Utility Commission has **directed** that the smart meter technology of covered EDCs, including PPL, **must support** at least the following capabilities:

1) Ability to provide 15-minute **or shorter** interval data **to** customers, EGSs, **third-parties** and the regional transmission organization ("RTO") on a daily basis, consistent with the data availability, transfer and security standards adopted by the RTO.

2) **Ability to upgrade these minimum capabilities as technology advances and becomes economically feasible**.

3) Ability to **remotely program** the meter.

4) Bidirectional data communications capability.

5) Remote disconnection and reconnection.

12. "The Fourth Amendment **can apply to a private utility if its acts were directed by the government**. If the search has been ordered or requested by the government, the private actor will become an 'instrument or agent of the state' and must abide by Fourth Amendment strictures." *Coolidge v. New Hampshire*, 403 U.S. 443, 487 (1971). (*Smart Meter Data: Privacy and Cybersecurity*. Congressional Research Service, CRS Report for Congress, Document R42338, February 3, 2012, p. 9.) (**EXHIBIT 51D**.) (Emphasis added.)

13. "[I]f a private party is required to perform a search or collect data under federal or state laws or regulations, there will be sufficient state action for the Fourth Amendment to apply. Or, put another way, the government cannot circumvent the Fourth Amendment by requiring a private party to initiate a search ... ." (*Smart Meter Data: Privacy and Cybersecurity*. Congressional Research Service, CRS Report for Congress, Document R42338, February 3, 2012, p. 10.) (**EXHIBIT 51D**.)

14. "Electricity, even more than telephone service, is a 'necessary component' of modern life, pervading every aspect of an individual's business and personal life: it heats our homes, powers our appliances, and lights our nights. A requirement of receiving this service is the disclosure to the power company (and in this case an agent of the state) of one's identity and the amount of electricity being used. The nature of electrical service requires the disclosure of this information, but that disclosure is only for the limited business purpose of obtaining the service." (*In re Restraint of Maxfield*, 133 Wn.2d 332, 341 (Wash. 1997).)

15. "If ... the government requested the utility to record larger quantities of data than was customary ..., this would likely warrant Fourth Amendment scrutiny." (*Smart Meter Data: Privacy and Cybersecurity*. Congressional Research Service, CRS Report for Congress, Document R42338, February 3, 2012, p. 10.) (**EXHIBIT 51D**.)

16. In quantity, the *customary* collection of customer data by PPL Electric Utilities always has been only inasmuch as has been necessary and sufficient to determine a customer's total usage of electricity and only insofar as is necessary and sufficient for the limited business purpose of generating a *monthly* bill for such usage. The *customary* data set that is necessary for calculating a monthly electric bill for a fixed-rate pricing program is obtained and obtainable by a once-per-month reading or collection of the aggregated total of electricity usage measured by the meter.

17. Given that there are 2880 15-minute intervals in a 30-day month, at least 2880 incremental data points would be required just to calculate total electricity usage by one customer over one month on the basis of such intervals.

18. There is no justifiable reason and certainly no necessity for an electric utility to require the collection of thousands of data points of incremental electricity usage in order to bill one customer for one month's total usage.

19. Collection of customers' electricity usage data more frequently than once per month is **not** necessary for the purposes of generating a monthly bill or account management, nor is such necessary for the operation and maintenance of the utility.

20. By collecting thousands of times more data than is required to calculate customers' monthly electric bills, PPL and the state's other electric utilities are exposing customers to unnecessary risks to their privacy.

21. "[T]he disclosure of power consumption to a utility company for billing or other limited business purposes does not relinquish the entirety of an individual's interest in the privacy of those records, especially where they contain information that is 750 to 3,000 times more detailed than the data customarily collected from standard analog electric meters." (Lerner, J. I. & Mulligan, D. K., *Taking the "Long View" on the Fourth Amendment: Stored Records and the Sanctity of the Home*, 2008 STANFORD TECHNOLOGY LAW REV. 13, ¶45.) (**EXHIBIT 51B**.)

22. It is reasonable that residential customers of the electric utilities not be required to surrender privacy interests beyond what is necessary for the utility to generate a monthly electric service bill.

23. **Without customers' informed consent**, any additional incremental measurement, collection or acquisition of electricity usage data which is more frequent than once per month, is unnecessarily intrusive and places an undue burden on customers' reasonable expectation of privacy.

24. We, the Complainants in the instant case, have surrendered a privacy interest in our electricity usage data **only insofar as and to the least extent necessary** to enable and account for monthly billing by PPL Electric Utilities.

25. We, the Complainants in the instant case, as customers of PPL Electric Utilities, have consented to the privacy risks and the disclosure of personal information only insofar as are necessary for once-per-month, aggregate measurement of our electricity usage and the calculation of our monthly electric bill—that is, for one (1) energy delivery data point per month measured in kWh and collected once per month.

26. We, the Complainants in the instant case, have ***never*** given our consent to, nor do we accept, the risks to our privacy and security which PPL would force us to accept by giving us no choice other than to permit the company, through the use of its wireless smart meter devices, to collect an amount of highly- granular data from our home which is thousands of times more than is necessary to calculate our monthly electric bill.

27. In terms of a monthly billing cycle, 15-minute or sub-15-minute incremental data measurements are **not** 'aggregate' measurements. Such data measurements are properly defined to be 'granular'. Measurement of electricity usage in kWh from one billing cycle to the next is the proper use of the term 'aggregate' measurement.

28. PPL has averred that, ***at the present time***, its wireless smart meter devices collect granular data from customers' homes and properties at 15-minute intervals. (See PPL's response to Complainants' Interrogatories, Set I, Question I-15.)

EXHIBIT 51E (FD):
*Electrical Power Consumption in **15-Minute Intervals** of Naperville Resident*. Customer electricity usage data graphically displayed for three separately-dated, 24-hour time periods, clearly showing details of home occupancy and of the occupants' activities while at home. Without applying any special software or analysis to disaggregate the data, it is quite easy to infer the occupants' activity patterns directly from the graphs. (Source: *A Perspective on How Smart Meters Invade Individual Privacy*, K. T. Weaver, Naperville, IL, August 22, 2014.)

29. Even the simplest data mining, pattern matching, and inference engine tools are capable of converting raw power consumption data into information discerning customers' behavior patterns and activities inside their homes.

30. Because granular data collected by smart meters at 15-minute intervals is certainly far more intrusive of customers' privacy, it is definitely reasonable that such collection of data should warrant much greater constitutional scrutiny than the customary, once-per-month collection of customers' aggregate data.

31. Utility customers therefore should expect, and definitely should receive, a **distinctly** higher level of protection, under both the Fourth Amendment and the Pennsylvania Constitution, from the utilities' frequent collection of highly-granular data than from the customary, much-less-frequent collection of simple, aggregate data.

32. "To obtain information lawfully about activity inside a home, law enforcement agents generally must obtain a warrant or receive permission to “enter” the home, even if “entry” does not entail setting foot inside the threshold. Private parties wishing to access and use information stored in the home must subpoena it and obtain a court order requiring production; otherwise, they must trespass upon private property to obtain it. In all instances, the law provides strong protections against access to personal information and other items maintained in the home. **Any data on personal behavior, habits, or energy usage that is maintained inside the home is customarily afforded the same high level of privacy protection against both private party and government intrusions**. The individual is able to exercise the highest level of control over the reuse and disclosure of personal information maintained inside the home." (Lerner, J. I. & Mulligan, D. K., *Taking*

the "Long View" on the Fourth Amendment: Stored Records and the Sanctity of the Home, 2008 STANFORD TECHNOLOGY LAW REV. 12, ¶44.) (**EXHIBIT 51B**.) (Emphasis added.)

33. PPL Electric Utilities, through the use its wireless smart meters, collects and transmits detailed, highly-granular electricity delivery data, relaying this information-containing data to PPL in a manner that is **identifiable with each individual customer account**.

34. No one, not any third party, not even a second party—as is PPL in this case—is entitled to possess our electricity usage data if that data potentially could be disaggregated and the information that it contains extracted to reveal in substantial detail private, personal activities inside our home.

35. Once the utility, or anyone other than the customer, has possession of the customer's personal and private information, **it is no longer private**.

36. The utilities thus cannot protect the privacy of customers' smart meter data; they can do no more than attempt to protect its confidentiality.

37. In the instant case, it is appropriate that "the Court take *Kyllo*'s 'long view' with respect to business records. When confronted with a business record or other information held by a third party, the Court should ask whether the record, or the technology used to create the record, reveals information about activities taking place inside the home that otherwise would not be available absent a trespass into the home. The Court should further inquire as to whether the consumer has been able to exercise any real choice about whether to create such records, or whether to maintain such records in the home. Because consumers have a reasonable expectation of privacy in activities that take place inside the home, if the answer to both questions is yes, then the information should be deemed to fall within the purview of the Fourth Amendment ... ."

...

... "The animating principle in *Kyllo* is the preservation of privacy in the home in the face of invasive technologies, and in light of that principle, the increasingly digitized and networked nature of our existence[88] should not vitiate the sanctity of the home and the expectation of privacy that individuals and society continue to maintain about activities taking place in the home."

...

"[88] See generally Orin S. Kerr, Searches and Seizures in a Digital World, 119 HARV. L. REV. 531 (2005); Jonathan Zittrain, Searches and Seizures in a Networked World, 119 HARV. L. REV. F. 83 (2006)."

(Lerner, J. I. & Mulligan, D. K., *Taking the "Long View" on the Fourth Amendment: Stored Records and the Sanctity of the Home*, 2008 STANFORD TECHNOLOGY LAW REV. 13, ¶ 46, 47.) (**EXHIBIT 51B**.)

38. "We consider the totality of the circumstances and carefully weigh the societal interests involved when determining the legitimacy of such an expectation [of privacy]." *Commonwealth v. Johnson*, 556 Pa. 216, 727 A.2d 1089, 1098 (1999), citing *Commonwealth v. Gordon*, 683 A.2d at 257 (1996).

39. It is certainly far more the electric utilities' interest than it is a compelling societal interest that individual customers be coerced and forced, under threat of termination of their electric service, to give their consent for the utilities to install and operate wireless smart meter devices on their homes.

40. Once we were to allow PPL Electric Utilities to collect highly-granular data that potentially could be used to reveal our private activities or information concerning the occupancy of our home, **then we permanently will have lost a considerable degree of privacy**.

41. It is **not** reasonable for individual customers "to be forced to participate in a system which gathers more [electricity] usage data than is required for billing purposes and which subjects them" definitely "to higher privacy and security risks than traditional" or customary, "monthly meter reads."

42. For PPL Electric Utilities to threaten, and the Pennsylvania Public Utility Commission to allow, termination of our access to electricity and to thus effectively deny us our right to refuse to consent to the unnecessary additional risks incurred through the collection and transmission, by wireless smart meter devices, of highly-granular usage data, constitutes an invasion of privacy from which Fourth Amendment protection clearly is warranted.

43. The collection of data containing intimate details "of one's activities over a prolonged period is substantially more invasive than a look at each item in isolation. [See *Central Intelligence Agency v. Sims*, 471 U.S. 159, 178 (1985).] In the case of smart meters, this is the difference between knowing a person's monthly energy usage, and being able to discern a person's daily activities with considerable accuracy." (*Smart Meter Data: Privacy and Cybersecurity*. Congressional Research Service, CRS Report for Congress, Document R42338, February 3, 2012, pp. 19-20.) (**EXHIBIT 51D**.)

44. The collection of data containing details of one's activities, like "surveillance normally permitted under the Fourth Amendment—such as monitoring a person's movements on a public street—**becomes an impermissible invasion of privacy**

when conducted on a prolonged, 24-hour basis." See *United States v. Maynard*, 615 F.3d 544, 562 (D.C. Cir. 2010). (*Smart Meter Data: Privacy and Cybersecurity*. Congressional Research Service, CRS Report for Congress, Document R42338, February 3, 2012, pp. 20-21.) (**EXHIBIT 51D**.) (Emphasis added.)

45. Traditional meters display data on a consumer's *total* electricity usage and are typically read manually once per month.[23] In contrast, smart meters can provide *near real-time* usage data by measuring usage electronically at a much greater frequency, such as once every 15 minutes.[24] Current smart meter technology allows utilities to measure usage as frequently as once every minute.[25] By examining smart meter data, it is possible to identify which appliances a consumer is using and at what times of the day, because each type of appliance generates a unique electric load "signature."[26] **NIST wrote in 2010 that "research shows that analyzing 15-minute interval aggregate household energy consumption data can by itself pinpoint the use of most major home appliances**."[27] A report for the Colorado Public Utilities Commission discussed an Italian study that used "artificial neural networks" to **identify individual "heavy-load appliance uses" with 90% accuracy using 15-minute interval data from a smart meter**.[28] Similarly, software-based algorithms would likely allow a person to extract the unique signatures of individual appliances from meter data that has been collected less frequently and is therefore less detailed.[29]

By combining appliance usage patterns, an observer could discern the behavior of occupants in a home over a period of time.[30] For example, the data could show whether a residence is occupied, how many people live in it, and whether it is "occupied by more people than usual."[31] According to the Department of Energy, smart meters may be able to reveal occupants' "daily schedules (including times when they are at or away from home or asleep), whether their homes are equipped with alarm systems, whether they own expensive electronic equipment such as plasma TVs, and whether they use certain types of medical equipment."[32]

[23] National Institute of Standards and Technology, *Guidelines for Smart Grid Cyber Security: Vol. 2, Privacy and the Smart Grid* 2, 9 (2010). http://csrc.nist.gov/publications/nistir/ir7628/nistir-7628_vol2.pdf [**EXHIBIT 51F (FD)**.]

[24] *Id*. at 13.

[25] Elias Leake Quinn, *Smart Metering & Privacy: Existing Law and Competing Policies: A Report For The Colorado Public Utilities Commission* 1, 12 (2009). http://www.dora.state.co.us/puc/docketsdecisions/DocketFilings/09I-593EG/09I-593EG_Spring2009Report-SmartGridPrivacy.pdf [**EXHIBIT 51G (FD).**]

[26] NIST Privacy Report, *supra* note 23, at 2, 14.

[27] *Id.* at 14.

[28] Colorado Privacy Report, *supra* note 25, at 3 n.7, A-8.

[29] *Id.* at A-9.

[30] NIST Privacy Report, *supra* note 23, at 6 & n.9.

[31] *Id.* at 11.

[32] Department of Energy, *Data Access and Privacy Issues Related To Smart Grid Technologies* 2 (2010). http://energy.gov/sites/prod/files/gcprod/documents/ [**EXHIBIT 51H (FD)**.]

(*Smart Meter Data: Privacy and Cybersecurity*. Congressional Research Service, CRS Report for Congress, Document R42338, February 3, 2012, pp. 3-4.) (Underlining and emphasis added.) (**EXHIBIT 51D**.)

46. "… Because smart meters collect energy data at much shorter time intervals than in the past (in 15-minute or sub-15-minute intervals rather than once a month), the information can reveal much more detailed information about the activities within a dwelling or other premises than was available in the past. This is because smart meter data provides information about the usage patterns for individual appliances—which in turn can reveal detailed information about activities within a premise **through the use of nonintrusive appliance load monitoring (NALM) techniques** … **research shows that analyzing 15-minute interval aggregate household energy consumption data can by itself pinpoint the use of most major home appliances**. … [S]uch detailed information about appliance use can also reveal whether a building is occupied or vacant, show residency patterns over time, and reflect intimate details of people's lives and their habits and preferences inside their homes." (NIST Document NISTIR 7628, pp. 13, 14.) (Underlining and emphasis added.) https://www.hsdl.org/?abstract&did=18739 and http://csrc.nist.gov/publications/nistir/ir7628/nistir-7628_vol2.pdf (**EXHIBIT 51F**.)

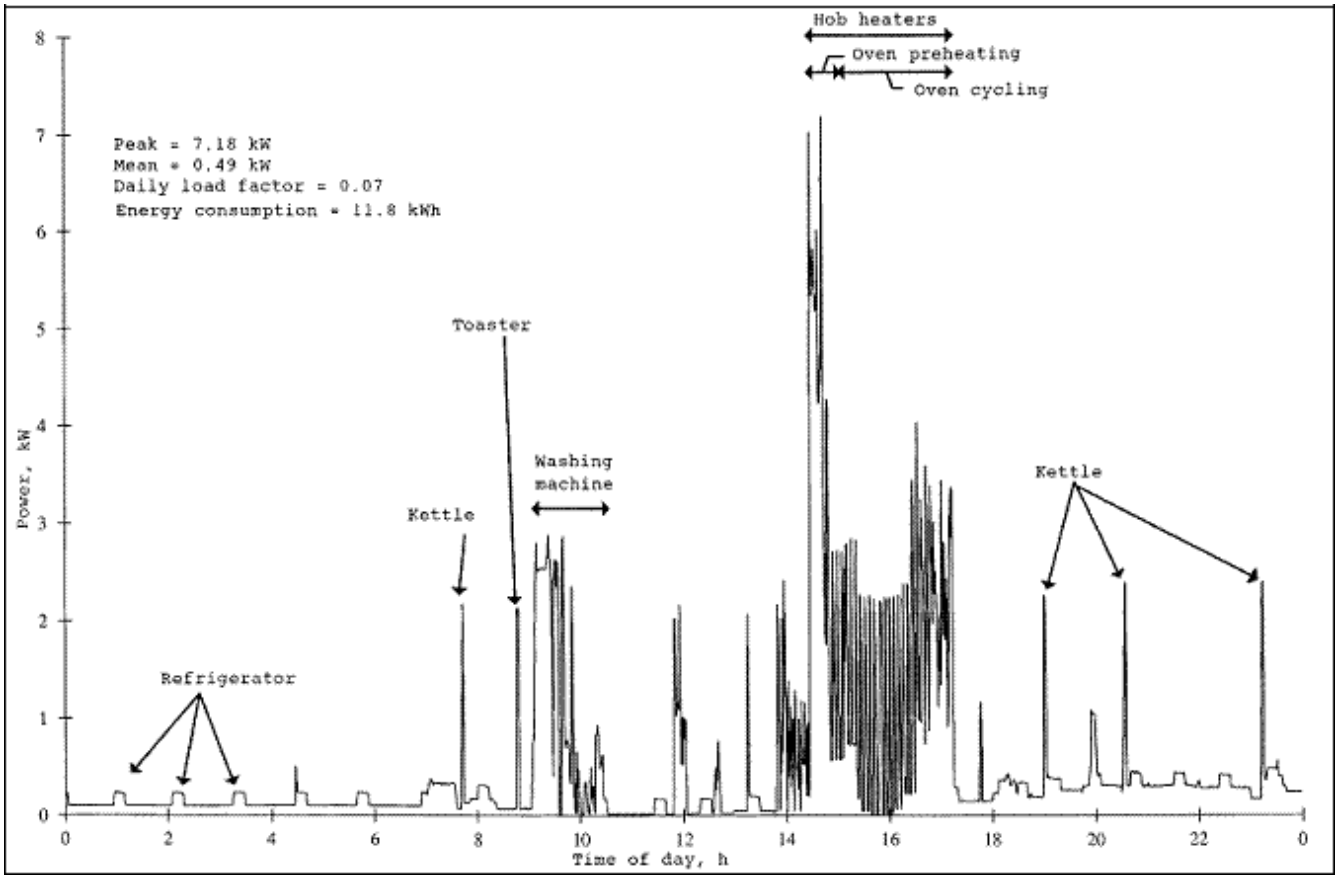
(*See also* Steven Drenker & Ab Kader, *Nonintrusive Monitoring of Electric Loads*, IEEE Computer
Applications in Power at pages 47, 50 (1999),
http://ieeexplore.ieee.org/iel5/67/17240/00795138.pdf?arnumber=795138.

47. With the use of smart meter technology, the astonishing detail that can be revealed about customers' private activities and behavior from their digitalized electricity usage data is shown by the following graphics:

EXHIBIT 51I (FD):

Identification of Household Activities from Electricity Usage Data

Unique Electric Load Signatures of Common Household Appliances



Source: NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST), GUIDELINES FOR SMART GRID CYBER SECURITY: VOL. 2, PRIVACY AND THE SMART GRID 13 (2010).

Note: Researchers constructed this picture from electricity usage data using a nonintrusive appliance load monitoring (NALM) device, which is similar to a smart meter in the way that it records usage data.

EXHIBIT 51J (FD):

Using Hidden Markov Models (HMM) to Produce an Appliance Disaggregation. Source: Draft NISTIR (NIST Interagency Report) 7628 Rev. 1. *Guidelines for Smart Grid Cybersecurity: Vol. 2, Privacy and the Smart Grid*. (October 2013.)

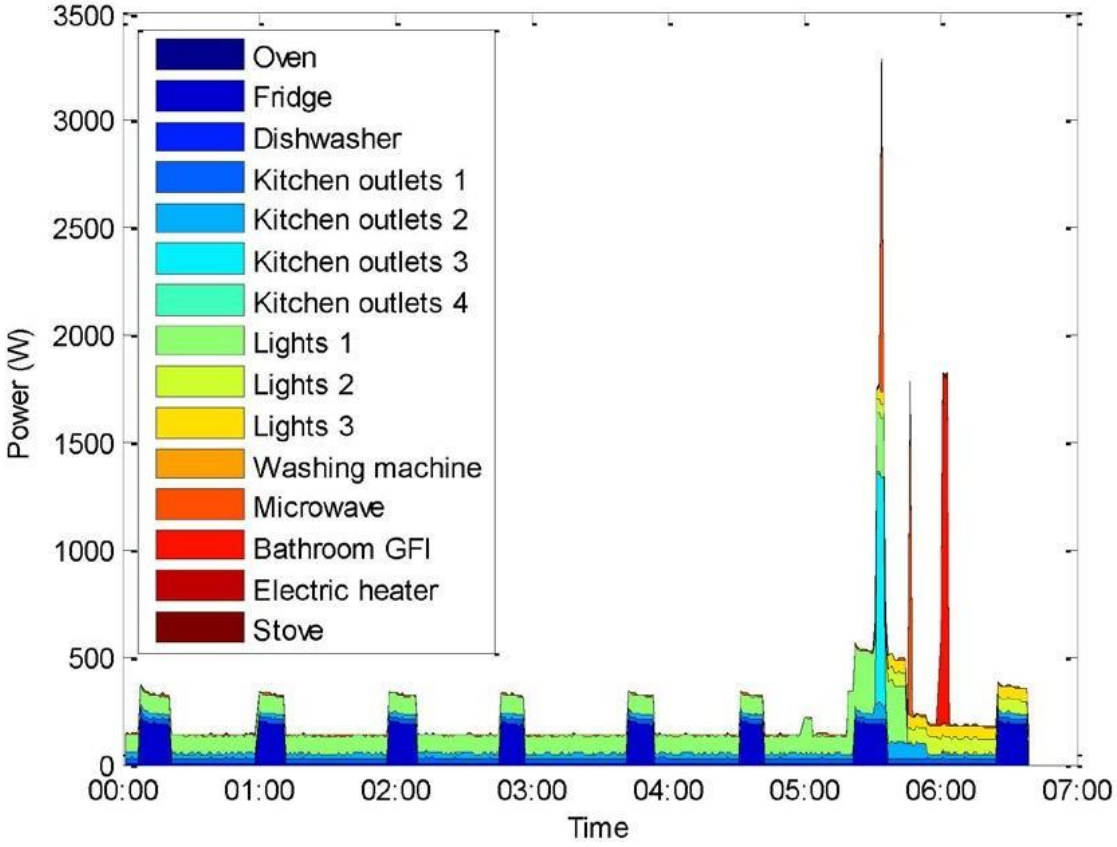


Figure 5-2 Using Hidden Markov Models (HMM) to Produce an Appliance Disaggregation[24]

48. "The non-intrusive appliance load monitoring (NALM) is a convenient approach to determine the energy consumption of individual appliances. The NALM employs only a single point of measurement, e.g., at the main electrical service entry point of the home, which does not require installing meters on each individual appliance. The NALM monitors the voltage and current of the total load and derives the activity of the individual appliances which constitute the load. Each appliance has electrical features that can be used as a unique 'signature' to recognize its contribution in the overall consumption. The most well developed NALM technique utilizes the signature given by the real and reactive power of the appliance during its steadystate operation." (*Compressive Sampling for Non-Intrusive Appliance Load Monitoring (NALM) Using Current Waveforms*, ACTA Press, June 2012.)

49. "[T]he massive deployment of smart meters across the country and the trend toward finer and finer interval data means that more and more information will be

discernible about more and more people. While the raw information about when an appliance event occurred in a given home may not seem to be sensitive information, it could be used to construct a detailed picture of residential life." (Colorado Privacy Report, 2009 (**EXHIBIT 51G,** p. 9.))

50. "A remarkable number of electric appliances can be identified by their load signatures, and with impressive accuracy. Researchers have all but mastered identification of the larger common household appliances such as water heaters, well pumps, furnace blowers, refrigerators, and air conditioners, with recognition accuracies approaching perfection. Ongoing work focuses now on the myriad smaller electric devices around the home such as personal computers, laser printers, and differentiating [types of] light bulbs." (Colorado Privacy Report, 2009 (**EXHIBIT 51G,** p.A-5.)) (One should note that the foregoing is a description of technological capabilities already available at least ten to twenty years prior to the present.)

51. A published article, entitled, "Leveraging Smart Meter Data to Recognize Home Appliances," was presented at the IEEE International Conference on Pervasive Computing and Communications in 2012. Excerpts from the article state the following:

"The worldwide adoption of smart meters that measure and communicate residential electricity consumption gives rise to the development of new energy efficiency services. Several particularly promising applications involve the disaggregation of individual appliances within a particular household in terms of their energy demand. … We generated 144 device-switching events in our test scenario. 16 of these came from devices with a consumption so small that the filter canceled out the corresponding edges. When subtracting these events, the algorithm identified 125 out of the remaining 128 events correctly, which results in an overall recognition rate of about 90%. … we are considering methods to derive occupancy state from electricity and appliance use data."

EXHIBIT 51K (FD):
Labeled load curve as output of the AppliSense algorithm, Graphic. Source: *Leveraging Smart Meter Data to Recognize Home Appliances*, IEEE International Conference on Pervasive Computing and Communications (2012).

EXHIBIT 51L (FD):
Private Memoirs of a Smart Meter. Andr´es Molina-Markham, Prashant Shenoy, Kevin Fu, Emmanuel Cecchet, and David Irwin, Department of Computer Science, University of Massachusetts Amherst, 2010.

This 2010 report shows that even ***without*** the somewhat sophisticated approach of using non-intrusive appliance load monitoring (NALM) techniques, simply **analyzing household real power readings *alone* is sufficient to reveal a range of information, such as when people are at home, sleeping routines, eating routines, etc.** The report reads in part:

"**The next generation of smart meters will reduce these time intervals to one minute or less**. For instance, in July 2010, PECO, one of the largest providers of electricity and gas in the U.S., selected Sensus to provide an AMI with meters that support one minute intervals [24].

"In this paper, we argue that the widespread deployment of smart meters has serious privacy implications since they inadvertently leak detailed information about household activities. The information leaks directly correlate with the time granularity that a meter measures power consumption. Unlike traditional dumb meters that record aggregate monthly usage for a utility, **today's smart meters allow an utility**, or a malicious party, **to glean detailed information about household activity in real-time from fine-grained usage measurements**. Further, research on **non-intrusive load monitoring (NILM) has shown that it is possible to disambiguate individual appliance usage from an aggregate smart meter power trace by using prior knowledge of an appliance's power signature**. **Such techniques** reduce or eliminate the need for outlet- or appliance-level meters, since they **are able to extract detailed usage information for individual appliances from an aggregate household power trace**.

"**We show that even without detailed knowledge of appliance signatures *a priori* or prior training, it is possible to extract complex usage patterns from smart meter data using off-the-shelf statistical methods**. Our methods are able to label specific types of activity in the home over time based on a number of characteristics, including the level of power consumption, its intermittency, and its duration. … [W]ith our limited data, we argue that it is possible to infer detailed information about household activity -- questions **such as how many people are in a home at a given time** and whether a resident went out for dinner on a particular evening, for example. Entities that gather large amounts of data would potentially be able to predict even more detailed facts, such as residents' genders and ages.

"Such information is a foundation for building powerful analytic tools for predicting behavior that could potentially be misused by companies or even criminals. ..." (Underlining, italics and emphasis added.)

EXHIBIT 51M-1 (FD):
Identification of Appliance Signatures by Computer Analysis Using Real Power and Reactive Power (VAR) Data. Source: Zeifman and Roth, *Non-Intrusive Appliance Load Monitoring (NIALM): Promise and Practice*, Fraunhofer USA, March 2012.

EXHIBIT 51M-2 (FD):
Multimedia Content Identification Through Smart Meter Power Usage Profiles. Ulrich Greveler, Benjamin Justus, and Dennis Loehr, Münster University of Applied Sciences D-48565 Steinfurt, Germany.

52. Again, it is clear that, even ***without*** NALM techniques, which can be used to produce a "virtual biography of in-home activity," extraordinarily detailed information on customers' personal activities, behavior and home occupancy can be gleaned simply by analyzing a graph of power usage versus time over the course of any 24-hour period.

53. Made possible with the advent of smart meters, the technology of identification of electrically-powered devices utilized in the home and the commoditization and monetization of customer data and information is burgeoning into a global, for-profit industry of **customer profiling**.

EXHIBIT 51N (FD):
Marketing advertisement, targeted to electric utilities and third parties, illustrating business of **sophisticated customer profiling** built upon collection, disaggregation analysis—data mining—and commoditization of customers' information contained in their smart meter data.

54. If reasonable persons, who highly value and wish to carefully guard their privacy, were properly and fully informed and clearly understood what can—and likely eventually will—be done, either intentionally or inadvertently, through the collection and transmission of their discretized, finely-granular, utilities usage data, they undoubtedly would find such excessively intrusive, unnecessary use of wireless smart meter devices and technology to be exploitative, repugnant, abhorrent, and outrageously invasive of their privacy.

55. "[M]ost customers are probably not familiar with the sophistication of smart meters and the detailed data sets that can be derived from them. Even if customers are aware their utility usage can be recorded in sub-fifteen minute intervals, a reasonable customer would probably be surprised, if not shocked, to know that data

from smart meters can potentially be used to pinpoint the usage of specific appliances." (*Smart Meter Data: Privacy and Cybersecurity*. Congressional Research Service, CRS Report for Congress, Document R42338, February 3, 2012, p. 22.) (**EXHIBIT 51D**.)

56. Customers' knowledge of the sophistication of the data that is being collected from them must be a prerequisite for them to be expected to give properly-informed consent for its use and to assume any consequent risk to their privacy.

57. Neither PPL nor the Pennsylvania Public Utility Commission has fully and properly informed customers and the public of the risks to their privacy and security through the sophisticated collection, transmission, use and/or potential use of their electricity consumption data by means of wireless smart meter devices and technology.

58. "**There is a lack of security features being built into smart grid systems.** Security features are not consistently built into smart grid devices. For example, our experts told us that certain currently available smart meters have not been designed with a strong security architecture and lack important security features ... ." (*Electricity Grid Modernization* U.S. General Accounting Office, GAO Report #GAO-11-117, January 2011, p. 24.) (Emphasis added.)

EXHIBIT 51O (FD):
Eavesdropping on the Smart Grid. C. Valli, A. Woodward, P. Hannay, C. Carpene, et al., School of Computer and Security Science, Edith Cowan University. December 2012. https://www.researchgate.net/publication/235636250
Reads in part:

"The research conducted for this project demonstrated conclusively that the technology as it currently stands has not been implemented according to network security best practices. This conclusion is based on the numerous vulnerabilities in both hardware and software and configurations that were discovered through the process of examining the equipment using a verifiable methodology."
...
"Given the increasing global awareness of the cyber threats against critical infrastructure, it is concerning that a technology which potentially provides a large attack surface for every owner of a smart meter to exploit is being developed and sold in such an insecure fashion."

EXHIBIT 51P (FD):
Testimony of Dr. Timothy Schoechle, PhD, at Iowa Utility Board hearing, December 5, 2018. Dr. Schoechle is a communications technology expert, international consultant in computer engineering, and Senior Research Fellow at the National Institute for Science, Law & Public Policy. He is a faculty member of Colorado State University-Global Campus where he develops graduate and undergraduate courses on cyber-security and privacy and is Principal Investigator for a research grant to demonstrate innovative electricity management, solar, and control system technologies for the City of Boulder. Dr. Schoechle's testimony concerns the difficult problems of securing utility customers' smart meter data to protect its confidentiality and preserve customers' privacy.

In his testimony, Dr. Schoechle avers: "I think that once the data is collected, you have **absolutely no control**, **even IPL [Interstate Power & Light] may not have control, over where the data goes**. We've seen that with the Marriott Hotel last week. The data was collected for one purpose, and it ends up going places no one imagines. That's just the way it is now. ... **The best way to protect data is to not collect it in the first place**. ... Regardless of what the pulsing rate [of the meters] is initially, it can be changed any time. And there's absolutely no assurance that it won't be changed the next day. ... **There is no assurance whatsoever that that pulse rate will remain the same**. ... They're all programmable in that respect. ... You can dynamically change those parameters over the network."

59. "Even privacy safeguards, such as 'anonymizing' data so that it does not reflect identity, are not foolproof.[42] By comparing anonymous data with information available in the public domain, it is sometimes possible to identify an individual—or, in the context of smart meter data, a particular household.[43] Moreover, **a smart grid will collect more than just electricity usage data. It will also store data on the account holder's name, service address, billing information, networked appliances in the home, and meter IP address, among other information**.[44] Many smart meters will also provide transactional records as they send data to the grid, which would show the time that the meter transmitted the data and the location or identity of the transmitter.[45]" (*Smart Meter Data: Privacy and Cybersecurity*. Congressional Research Service, CRS Report for Congress, Document R42338, February 3, 2012, p. 6.) (**EXHIBIT 51D**.) (Emphasis added.)

42 *See* NAT'L INST. OF STANDARDS AND TECH., GUIDELINES FOR SMART GRID CYBER SECURITY:
VOL. 2, PRIVACY AND THE SMART GRID 13 (2010), [**EXHIBIT 51F**] *available at* http://csrc.nist.gov/publications/nistir/ir7628/nistir-7628_vol2.pdf.
43 *See id.* at 13, 25.
44 *Id.* at 26-27.
45 *Id.* at 12 (drawing a comparison to telecommunications providers' "call detail records").

In PPL's response to Complainants' Interrogatories, Set I, Question I-15, PPL has averred that:

"PPL Electric only collects the information as required by the Pennsylvania Public Utility Commission's *Smart Meter Implementation Order* entered on June 24, 2009, at Docket No. M-2009-2092655.

"[T]hrough the new meters, PPL only collects electric usage data and significant event information, such as outages, voltage, heat alarms and meter tampering alerts. ...

"[T]he Company only collects information about the total electric usage at the premises. The information does not differentiate between the use of any specific appliance or appliances.

"The AMI data is collected, used, and protected from public disclosure in accordance with PPL Electric's AMI Customer Privacy Policy and the Company's Commission-approved Smart Meter Plan. *See* Docket No. M-2014-2430781."

EXHIBIT 51Q-1 (FD):
PA PUC Implementation Order: *Smart Meter Procurement and Installation* (Docket No. M-2009-2092655) (Entered: June 24, 2009).

EXHIBIT 51Q-2 (FD):
PPL Electric Utilities *Petition for Approval of a Smart Meter Technology Procurement and Installation Plan* (Docket No. M-2009-2123945) (Aug. 14, 2009).

EXHIBIT 51Q-3 (FD):
ALJ Initial Decision RE: *Petition of PPL Electric Utilities Corporation for Approval of a Smart Meter Technology Procurement and Installation Plan* (Docket No. M-2009-2123945) (Jan. 21, 2010).

EXHIBIT 51Q-4 (FD):
PA PUC Order: *Petition of PPL Electric Utilities Corporation for Approval of a Smart Meter Technology Procurement and Installation Plan* (Docket No. M-2009-2123945) (Entered: June 24, 2010).

EXHIBIT 51R (FD):
PA PUC Opinion and Order: *Interim Guidelines for Eligible Customer Lists* (Docket No. M-2010-2183412) (Entered: Nov. 12, 2010).

EXHIBIT 51S (FD):
Pa. PUC to Not Allow Customers to Restrict All Information from Customer Lists. Energy Choice Matters news report, dated November 15, 2010. Reads in part:

[Customer lists - Begin quote]

The Pennsylvania PUC adopted a final order Friday establishing interim guidelines for eligible customer lists (ECL) to be made available to electric generation suppliers by electric distribution companies (M-2010-2183412). ...

The final order does not materially depart from a tentative order issued in July (7/16).

Notably, the interim guidelines do not allow customers to restrict all of their information from the customer list. Customers may restrict, through affirmative opt-out, only their service addresses, historical billing data, and/or telephone numbers. ...

Vice Chairman Tyrone Christy dissented, in large part due to the inability of customers to restrict information other than their service address, historical billing data, and/or telephone number. Commissioner Wayne Gardner dissented in part due to the inclusion of phone numbers on the lists.

"I support the promotion of competition. However, **the information to be released to these non-regulated, private companies contains personal information including individuals' telephone numbers**. These guidelines provide that customers may opt-out of having their telephone numbers released but **if they do not opt-out, their phone numbers will be given to any EGS that requests it**," Gardner said.

"**It is inappropriate as a government agency to require our regulated companies to release the telephone number of their customers to private, unregulated, businesses.** Many people guard their telephone numbers closely and they would not want their numbers given to companies so that they can receive sales calls. Additionally, the provision in **this Order requiring that customers' telephone numbers be released to EGSs without the customer's consent**, could have the unintended consequence of harming competition by leaving a negative impression of EGSs on those who receive sales calls from them. Finally, **there is no legitimate reason to release customers' phone numbers**. The purpose of the

ECL is to provide information to EGSs that will assist them in preparing competitive offers to potential customers. A phone number is not needed to accomplish this as the **EGSs will have access to sufficient information including the customer's name, billing address, usage information and other data** that will allow them to market their products and services," Gardner said.

"**[T]he Commission is mandating that EDCs release most customer information to all EGSs even if the customer strenuously objects,"** Christy said.

"**This is the first instance of which I am aware in which a State utility commission has decreed that there will be neither an opt-in requirement nor an opt-out right before private customer information is released to third parties**," Christy added.

"**Any marginal increase in shopping statistics as a result of the mandatory release of customer information will be accompanied by the loss of consumer privacy protections -- an unacceptable trade-off**," Christy said.

Christy said that by citing phone number and historical usage as examples, **52 Pa. Code §54.8 did not intend that such information is to be the only information customers can restrict from being shared with suppliers**.

Furthermore, Christy interprets the final order as not including monthly on-peak and off-peak usage and load factors as falling under the definition of historic usage data, and thus **customers will not be able to prevent the sharing of such monthly on-peak and off-peak usage and load factor information**.

Christy argued that the sharing of such information would violate 66 Pa. C.S. §2807(f)(3), which provides that EDCs shall make customer meter data available to suppliers "with customer consent."

[Customer lists - End quote]

EXHIBIT 51T (FD):
Office of Consumer Advocate (OCA) Main Brief RE: *PPL Petition for Approval of its SMP* (Docket No. M-2014-2430781) (Jan. 13, 2015). Reads in part:

[OCA Main Brief - Begin quote]

I. Data Privacy Issues

Smart meters have the capacity to provide a great deal of information about a customer's life and habits or about a business operation. As such, the protection of

customers' personal and usage data must be a critical component of a Smart Meter Plan. PPL's proposed Plan states that one of its objectives is to "address cyber security and privacy of customer data concerns." Plan at 4. The Plan contains a section that addresses the Company's plan to protect the privacy of its customers. See Plan at 35-42. **OCA witness Nancy Brockway reviewed PPL's proposed Plan, as well as its current privacy policies, and determined that the Company's proposed Plan is not complete and does not address the unique challenges of customer privacy resulting from the deployment of smart meters**. See OCA St. 3 at 30; OCA St. 3-S at 7. Ms. Brockway summarized her testimony regarding her concerns with the Company's privacy policies as follows:

I reviewed the privacy policies of PPL Electric that I could find, and showed their limitations from a SMIP perspective. I recited that PPL Electric intends to address privacy issues with an engineering group, who will not be aware of the privacy concerns from the customer perspective. I noted that the Company makes no mention of Green Button privacy issues in its SMIP or elsewhere. **I concluded that PPL either does not yet have a sense of what information its customers might like it to protect as private, or has not fully described its approach to privacy in the SMIP**. I also concluded that PPL considers privacy a sub-set of cyber-security, rather than a topic that needs to be addressed on its own terms. **The Company's SMIP as written is unlikely to lead to privacy policies that address customers' desire for privacy in an advanced metering world**.

OCA St. 3-S at 7. (Citations omitted).

In support of her conclusion that the privacy component of the Plan is incomplete and needs to be revised, **Ms. Brockway testified that the Company's Plan fails to address critical issues essential to customer privacy**. For example, **the Company's proposed Plan does not provide the privacy risks that the Company anticipates it will face as a result of the implementation of the new smart meters**. Specifically, Ms. Brockway stated:

It references an **assessment yet to be undertaken to assess privacy risks, without giving the impression that the Company has any sense of the information that customers will want to secure from distribution as part of their privacy needs**. Indeed, **one can read the Petition and the SMIP and have no idea of what information PPL thinks that customers will consider private**.

OCA St. 3 at 28. **Ms. Brockway also testified that the Company does not identify potential areas of dispute such as what information must be kept private**, **how it plans to enforce privacy policies on third parties while permitting customers to release their own data**, or other issues that have arisen when states have addressed the privacy implications of smart meter technology.

OCA St. 3 at 28. As such, **Ms. Brockway testified that the Company should "be required to revise the privacy components of its SMIP**, and that it do so with the assistance of employees well-versed in customer service issues, and of stakeholders who are able to communicate various consumers' desires for privacy." OCA St. 3-S at 7.

PPL witness Kent Simendinger disputed that there is a need to revise the Company's privacy components of its Plan. PPL St. 5-R at 4. Mr. Simendinger testified that "PPL Electric's current standards and procedures as outlined in its privacy policy are evident, and aligned to its overall cybersecurity protections, which protect customer data and its privacy in its collection, storage, transit and access by customers, third parties [. . .], and PPL Electric staff." PPL St. 5-R at 4. He went on to state that, as "specific technical solutions and updated business process and procedures for the smart meter project evolve, so too will cybersecurity protection of associated customer information, and the data privacy procedures and customer communications regarding PPL Electric's commitment to data privacy." PPL St. 5-R at 4.

Mr. Simendinger's testimony, however, did not adequately address the privacy concerns raised by Ms. Brockway. **The privacy policy referenced in Mr. Simendinger's Rebuttal Testimony is limited to personal data obtained via the Company's website, and does not extend to personal data that the Company has obtained in another manner, such as over the phone or by mail, or to usage data collected by the smart meter**. See PPL St. l-R, Exhibit KTS l-R at 1. As Ms. Brockway pointed out in testimony:

Smart meters provide data to the company through "means other than" the Company's website. Thus, the privacy policy set out in Exhibit KTS l-R (and the companion Terms of Use of the Company's website) **do not apply to the major source of new information about customers' usage that will be supplied by smart meters**.

OCA St. 3-R at 8. **Ms. Brockway further testified that the "Privacy Policy" provided in Exhibit KTS 1-R does not direct customers to a privacy policy for personal data obtained by means other than the Company's website**, **nor does the privacy policy address how the Company will handle smart meter data**. OCA St. 3-R at 9.

In Rejoinder Testimony, Mr. Simendinger acknowledged that the existing privacy policy is directed towards protecting personal data collected via the use of its website, but stated that it is the Company's intention to use the current privacy policy as a model that will be "enhanced to address data privacy and cybersecurity protections beyond just the website, such as for use of smart meters." PPL St. 5-RJ

at 3. Mr. Simendinger explained that any new or revised privacy policies "must await fundamental decisions on the ultimate smart meter technology and design, to determine what customer data can (e.g. technical limitations) and will be collected beyond that already described in the website Privacy Policy... ." PPL St. 5-RJ at 3. Mr. Simendinger further stated in his Rejoinder Testimony that the Company should not be required to revise the privacy component of its Plan to include a commitment to use customer service personnel because PPL's customer service employees are already "engaged as part of the Smart Meter project team to address data privacy matters among many other aspects of the project's scope, working with cybersecurity and engineering resources, to keep customer data private and secure." PPL St. 5-RJ at 3.

The OCA submits that it appears that the Company does not object to the substance of Ms. Brockway's recommendations, but merely the need to include these recommendations into the Order approving the Plan. See PPL St. 5-RJ at 3. **The OCA submits that any Order approving the Plan should explicitly state what the Company is required to do in relation to data privacy protection, as the ability to protect customer information is a critical responsibility of any EDC deploying smart meters**. The OCA notes that the Commission has required other EDCs to work with Stakeholders to develop stand-alone customer privacy policies specifically related to the protection of smart meter information before deployment of the smart meters, and such a directive is appropriate here. See, Joint Petition of Metropolitan Edison Company. Pennsylvania Electric Company. Pennsylvania Power Company and West Penn Power Company for Approval of Their Smart Meter Deployment Plan, Docket Nos. M-2013-2341990, M-2013-2341991, M-2013-2341993, M-2013-234l994, Order at 47 (March 6, 2014). As such, the OCA submits that the Company should be directed to develop a stand-alone customer privacy policy relating to the deployment of smart meter technology using customer service employees as part of its smart meter team and with the input of stakeholders who are able to communicate various customers' desires for privacy.

[OCA Main Brief - End quote] (Underlining and emphasis added.)

EXHIBIT 51U (FD):
Coalition for Affordable Utility Services and Energy Efficiency in PA (CAUSE-PA) Main Brief RE: *PPL Petition for Approval of its SMP* (Docket No. M-2014-2430781) (Jan. 13, 2015). Reads in part:

[CAUSE-PA Main Brief - Begin quote]

IV. BURDEN OF PROOF

PPL has the burden of proof in this case, as it is the proponent of a Commission order granting its Petition and approving its Plan. 66 Pa.C.S.A. § 332(a). In its January 21, 2010 Initial Order in the prior PPL Smart Meter Plan proceeding, the Honorable Wayne L. Weismandel, Administrative Law Judge, provided a detailed description of the standards PPL must meet to fulfill its burden of proof in this case:

To establish a sufficient case and satisfy the burden of proof, PPL must bear its burden by a preponderance of the evidence. *Samuel J. Lansberry, Inc. v. Pa. Public Utility Comm'n*, 134 Pa.Cmwlth. 218; 221-222, 578 A.2d 600; 602 (1990), app. denied, 529 Pa. 654, 602 A.2d 863 (1992). That is, by presenting evidence more convincing, by even the smallest amount, than that presented by the other party. *Se-Ling Hosiery v. Margulies*, 364 Pa. 45, 70 A.2d 854 (1950). PPL must initially produce sufficient credible evidence to establish a prima facie case in order that it not lose summarily. *Morrissey v. Dep't of Highways*, 424 Pa. 87, 225 A.2d 895 (1967). If PPL does so, the burden of going forward with evidence shifts to the parties opposing its Petition to produce credible evidence of at least co-equal weight. This burden of going forward with evidence may shift back and forth between the parties, but **the ultimate burden of persuasion remains with PPL**. *Milkie v. Pa. Public Utility Comm'n*, 768 A.2d 1217 (Pa.Cmwlth. 2001).

Additionally, **any finding of fact necessary to support the Commission's adjudication must be based upon substantial evidence**. *Mill v. Pa. Public Utility Comm'n*, 67 Pa.Cmwlth. 597, 447 A.2d 1100 (1982), *Edan Transportation Corp. v. Pa. Public Utility Comm'n*, 154 Pa.Cmwlth. 21, 623 A.2d 6 (1993), 2 Pa.C.S. § 704. **Substantial evidence has been defined as such relevant evidence as a reasonable mind might accept as adequate to support a conclusion**. *Bethenergy Mines, Inc. v. Workmen's Compensation Appeal Bd. (Skirpan)*, 531 Pa. 287, 612 A.2d 434 (1992). More is required than a mere trace of evidence or a suspicion of the existence of a fact sought to be established. *Norfolk and Western Ry. v. Pa. Public Utility Comm'n*, 489 Pa. 109, 413 A.2d 1037 (1980); *Erie Resistor Corp. v. Unemployment Compensation Bd. of Review*, 194 Pa.Super. 278, 166 A.2d 96 (1960); *Murphy v. Dep't of Public Welfare*, 85 Pa.Cmwlth. 23, 480 A.2d 382 (1984).[1]

In short, PPL has the burden of submitting substantial evidence to prove, by a preponderance of evidence, that its Petition should be granted.

[1] Petition of PPL Electric Utilities Corporation for Approval of a Smart Meter Technology Procurement and Installation Plan, Initial Decision, Docket No. M-2009-2123945, at 19-20 (Jan. 28, 2010). [Ref. **EXHIBIT 51Q-3**.]

...

V. SUMMARY OF ARGUMENT

PPL's Smart Meter Plan (SMP) lacks critical information necessary for the Commission to make a just and sound determination about the reasonableness and prudence of its proposed investment in wholly new technology, which it seeks to implement on an expedited basis.

...

PPL's SMP also lacks a detailed, stand-alone data privacy plan, which is a critical component necessary to ensure that the sensitive data collected by its new meters will not be unnecessarily exposed to unauthorized disclosure. **The record clearly demonstrates that PPL's existing policies are inadequate to address the privacy risks associated with smart meter technology, and raises substantial question about the efficacy of PPL's plans to rely on these policies as a baseline for smart meter data privacy policies**. Moreover, **its current Supplier Portal program provides an inappropriately broad disclosure of customer information, without offering customers the option of protecting their information**. **This unverified, open-door approach to disseminating customer data is inconsistent with existing privacy laws and policy, and must be addressed to ensure that the Supplier Portal does not undermine attempts to protect data** through strong front-end cyber-security and data privacy plans.

...

VI. ARGUMENT

...

I. Data Privacy Issues

General Data Privacy Issues

PPL's Petition, as well as the record put forth in support thereof, includes very little detail regarding its plans for safeguarding the privacy of customer data transmitted or collected by the new meter technology, and inappropriately relies on *existing* policies to govern smart meter data.[34]

PPL states that the company will deal with data privacy issues by maintaining an internal workgroup and by utilizing third-party experts.[35] And, in its SMP, provides further that its internal working group, IAG, "will also follow 'Guidelines for Smart Grid Cybersecurity: Vol. 2, Privacy and the Smart Grid' recommendation sand [sic] conduct a privacy impact assessment (PIA) before any deployment…[which] will help the project team with the following: identifying and managing privacy risks, … [a]voiding unnecessary costs, … and [m]eeting legal requirements."[36] But, rather than develop a specific policy and procedure for smart meter data privacy for the Commission to approve, PPL argues that it is sufficient for it to comply with its existing policies and procedures, and that its privacy policy should only be expanded on an as-needed basis:[37]

PPL Electric *does not agree that a revision is necessary to the privacy components of its smart meter plan*. PPL Electric's current standards and procedures as outlined in its privacy policy are evident, and aligned to its overall cybersecurity protections, which protect customer data and its privacy in its collection, storage, transit and access by customers, third parties such as those who support the provision of self-service energy analytics to PPL Electric customers, and PPL Electric staff.[38]

In all, **PPL's existing privacy policy is overly broad and presents a wholly insufficient policy to address the enormity of the risk associated with smart meter data privacy.**[39] **PPL's current Privacy Notice, which is available to customers on its website, reserves the right for PPL to use "the *energy*, technical and reference information it collects (in aggregate or *individual form*) for, among other things, the following purposes:**

- Sending requested messaging
- Processing requests
- Service provisioning
- Account creation and maintenance
- Billing
- **Promotion**
- **Advertising**
- Customer support
- Site customization
- **Statistical analysis**
- Background charts, reporting and collecting debts
- Product development
- **Marketing**
- Announcements
- Content improvement
- Technical support
- Security or law enforcement investigations
- Cooperation with legal requirements
- Protecting our rights and property, and that of other Users[40]

The Privacy Notice also leaves open the possibility that PPL may "rent, license, or sell Personal Information, **defined as "including the customer's name, address, password, home service, domain and email address, transaction, billing and payment history, and usage, among other things",**[41] **to third parties**.[42] **The long list of possible uses for customer's *energy information* (defined as including account number**, rate class, **electricity kWh usage** and electricity supplier) **is impossibly broad, and opens sensitive data to broad disclosure.**

So, **the question then becomes whether a customer who accesses PPL's website to pay their bill online or to access their pricing and consumption data through PPL's Energy Analyzer website exposes their smart meter data to broad disclosure under the company's existing Privacy Notice. Without a specific, stand-alone policy to address data privacy issues for smart meter data, the answer to that question will be "yes" – the information accessed online would be subject to broad disclosure at the option of PPL**. As indicated by the National Institute of Standards and Technology in its *Guidelines for Smart Grid Cybersecurity: Vol. 2, Privacy and Smart Grid*, **which PPL pledges in its Petition to follow,[43] "New Smart Grid technologies, and particularly smart meters, … create new privacy risks and concerns that may not be addressed adequately by the existing business policies and practices of utilities and third-party Smart Grid providers**."[44]

Given that data privacy is intrinsically linked to customer safety, it is particularly important for public utilities to be diligent to the ever-increasing threats associated with data privacy.[45] But PPL's proposal with respect to data privacy lacks prudent foresight. **CAUSE-PA therefore urges the Commission to require PPL to revise its SMP to include a specific and detailed data privacy plan,** in consultation with interested stakeholders. Doing so would ensure that PPL is fully prepared for the added risk to personal data privacy posed by implementation of new, more advanced smart meter technology.

Supplier Portal

It is imperative that the Commission order PPL to revise its policy and procedure regarding access to the Supplier Portal to enable customers to protect their information from inclusion on the Supplier Portal and to require verification of EGS certifications. Act 129 provides that "[e]lectric distribution companies shall*, with customer consent,* make available direct meter access and electronic access to customer meter data to third parties, including electric generation suppliers and providers of conservation and load management services."[46]

In accordance with guidance and direction from the Commission, PPL adopted a Supplier Portal to make information available to suppliers.[47] However, the Supplier Portal goes far beyond providing access to customer information, and allows electric generation suppliers nearly unfettered access to extremely sensitive personally identifying information, including the customer's Social Security number and detailed usage data, without obtaining verification of customer consent.[48] As PPL explained, "[t]o search for an account number, the EGS or 3rd party must know the name of the customer

as it appears on the customer's PPL electric bill at a minimum."[49] And, once the customer's name is supplied (or, if the name is not known, the phone number, Social Security Number, e-mail address, meter number, or premises address), an EGS or 3rd party can access a plethora of personal information, including the customer's Social Security Number.[50] After providing the customer's name, the EGS or third party must self-certify that they have the customer's authorization and that they have verified the customer's identification.[51] But, to put those added self-certification requirements in context, the sole protection that these self-certifications rest alone on is the "integrity" of the EGS or the 3rd party, without any verification by PPL to ensure that their customer's information is protected.[52]

At the final hearing, it was further revealed that "the customer's designation of their data as confidential or nonconfidential does not affect the EGS or third party's ability to access customer data through the supplier portal."[53] So, not only is the information easy to access, it is also impossible to protect from dissemination. And, once information is disseminated, the harm is difficult for a customer to remedy or ameliorate. While PPL maintains an event log, wherein each attempt to lookup an account is recorded and traceable, the procedure for a customer to access that information is uncertain, and PPL has not provided any assurances that it could provide a requester with an event log within 10 business days.[54] And in any event, the customer would need to know that the breach was a result of the Supplier Portal, which may be wholly unrelated to the ultimate harm they suffer as a result of a breach.

Essentially, the Supplier Portal undermines and effectively thwarts any attempt by PPL to address personal data privacy through the creation of a robust policy and detailed protocols and procedures because it creates a shortcut for an unknown number of individuals to access highly sensitive data, leaving the system vulnerable to widespread and irremediable abuse.

[34] Pet. at 19, ¶ 56-57.
[35] Pet. at 19, ¶ 56.
[36] PPL SMP at 41.
[37] PPL St. 5-R, Simendinger, at 3. In Rejoinder Testimony, Mr. Simendinger did attempt to backtrack a bit from his earlier testimony position that a new policy was unnecessary, and explained:
The existing Privacy Policy is aimed at the use of the website, but my rebuttal testimony … was intended to convey how such a policy can and will be extrapolated and enhanced to address data privacy and cybersecurity protections beyond just the website, such as for use of smart meters. Such an enhancement, or potentially new separate policy must await fundamental decisions on the ultimate smart meter technology and design, to determine what customers data can … and

will be collected beyond that already described in the website Privacy Policy, and how such data will be handled and protected via cybersecurity and business process data privacy measures given the nature of the technology and supporting business processes.

Id. While this concession offers some measure of certainty with respect to PPL's plans, it does not instill confidence that a separate policy will be developed. As explained above in further depth throughout this section, the existing regulations on confidentiality are easily circumvented with a simple disclaimer. Strong policies and procedures with respect to data privacy are necessary to prevent unauthorized disclosure of information before a breach occurs, not after.

[38] PPL St. 5-R, Simendinger, at 4.

[39] *See* OCA St. 3, Brockway, at 22-30.

[40] PPL Exhibit KTS-1-R, at 2 (emphasis added); *see* also OCA St. 3, Brockway, at 24-25.

[41] OCA St. 3, Brockway, at 24-25.

[42] OCA St. 3, Brockway, at 25; see also PPL Exhibit KTS-1-R. In relevant part, PPL's Privacy Notice states:

PPL may share the Personal Information we collect on the Site with others for a variety of reasons. PPL does not ***currently*** rent, license, or sell Personal Information to third parties. In addition to the kinds of information you might expect, such as **sharing with third parties who need your information** in order to provide services to us or on our behalf and subject to confidentiality agreements.

Id. (emphasis added).

[43] PPL SMP at 41 (citing Nat'l Inst. of Std. and Tech, US Dep't of Commerce, Guidelines for Smart Grid Cyper Security: Vol. 2, Privacy and the Smart Grid (Aug. 2010), *available at* http://csrc.nist.gov/publications/nistir/ir7628/nistir-7628_vol2.pdf ("For the Smart Meter Project, IAG will also follow 'Guidelines for Smart Grid Cybersecurity; Vol. 2, Privacy and the Smart Grid' recommendation sand [sic] conduct a privacy impact assessment (PIA) before any deployment.") [hereinafter NIST Guidelines].

[44] NIST Guidelines at 2; *see also* PPL SMP at 41; CAUSE-PA Exhibit 1, at CAUSE-PA to PPL II-1.

[45] NIST guidance asserts that a detailed privacy policy should be developed before deployment of smart meter technology.

[46] 66 Pa. C.S. § 2807(f)(3).

[47] CAUSE-PA Exhibit 1, at OCA III-Q6, Attachment 1, page 141 of 68 (citing 2010 Implementation Order at 22).

[48] CAUSE-PA Exhibit 1, at OCA III-Q6, Attachment 1, page 141 of 68.

[49] CAUSE-PA Exhibit 1, at OCA III-Q6, Attachment 1, page 143 of 68; see also CAUSE PA Exhibit 1, at CAUSE-PA to PPL I-7 ("If the customer does not have their PPL Electric account number readily available at the time of an in-person enrollment, the EGS or [3]rd party can search the account number based on inputted data.").

[50] CAUSE-PA Exhibit 1, at OCA III-Q6, Attachment 1, page 143 of 68 (depicting the Account Number Lookup function in the Supplier Portal, which shows the available data that can be inputted to pull up a customer account without a name or account number.).
[51] Tr. at 60.
[52] Tr. at 60; *see also* CAUSE-PA Exhibit 1, at CAUSE-PA to PPL I-7 (D).
[53] Tr. at 60.
[54] *Id.*; CAUSE-PA Exhibit 1, at OCA III-Q6, Attachment 1, page 143 of 68.

[CAUSE-PA Main Brief - End quote] (Underlining and emphasis added.)

EXHIBIT 51V (FD):
PP&L Industrial Customer Alliance (PPLICA) Main Brief RE: *PPL Petition for Approval of its SMP* (Docket No. M-2014-2430781) (Jan. 13, 2015). Reads in part:

[PPLICA Main Brief - Begin quote]

PPLICA's Main Brief will address PPLICA's concerns with the privacy of customer data available to Electric Generation Suppliers ("EGS") and authorized 3rd parties through PPL's Supplier Portal.
...
PPLICA remains concerned that the Supplier Portal raises important customer privacy considerations.[2] For example, while PPL has confirmed that the Supplier Portal will maintain an event log documenting requests for customer usage data for at least 3 years, PPL has also indicated that certain situations may prevent the Company from accommodating a customer's request for event log data. To ensure that PPL's Supplier Portal provides customers with a clear and transparent opportunity to protect their usage data, PPLICA recommends that the Commission direct PPL to develop and file specific guidelines outlining the factors to be considered in responding to a customer request for event log data. Absent a compelling reason, all reasonable requests should be fulfilled. Additionally, PPLICA recommends that the Commission consider the necessity to refine its customer privacy regulations as PPL and other Electric Distribution Companies ("EDCs") install more automated data storage and communications technologies.
...
[2] PPL introduced the Supplier Portal as a limited pilot program in 2012. *See Petition of PPL Electric Utilities Corporation for Approval to Modify its Smart Meter Technology Procurement and Installation Plan and to Extend its Grace Period*, Docket No. M-2009-2123945 (August 1, 2012).
...
II. ARGUMENT

A. Privacy of Customer Data Available Through Supplier Portal

As indicated above, PPL's SMPI includes a proposal to implement a Supplier Portal for purposes of facilitating EGS and 3rd party access to customer usage data. According to PPL, the Supplier Portal was developed to be consistent with the Commission's existing privacy requirements for EGSs and 3rd parties. Unfortunately, **the practical consequences of expanding these policies to a fully automated electronic database indicate that the Commission's policies inadequately protect customers' usage data**. To maximize customer protections available through PPL's Supplier Portal within the framework of the Commission's existing privacy policies, PPLICA has worked with PPL to implement recordkeeping policies allowing for monitoring and investigation of unauthorized use of the platform. As discussed below, PPLICA also requests that the Commission direct PPL to adopt specific protocols for evaluating customer requests for event log data. Notwithstanding such improvements to PPL's Supplier Portal, PPLICA remains concerned that **customer usage data will remain at risk absent additional Commission action to refine current policies placing the burden of monitoring access to customer usage data on the customer**.

PPL designed the Supplier Portal to increase the efficiency of data access while preserving the framework of the Commission's existing customer privacy policies. PPL Exhibit No. 1, Appendix C, p. 19. As described by PPL, the purpose of the Supplier Portal is to "create a secure data environment wherein EGSs, and potentially other 3rd parties, can, with appropriate customer authorization, access customers' usage data directly without need for an EDI request and response." *See id.* Through responses to PPLICA's discovery questions, **PPL further clarified that the phrase "secure data environment" refers to the technical cybersecurity measures taken to protect data stored in the Supplier Portal**. *See* PPLICA Cross-Examination Exhibit No. 1, p. 1. PPL similarly clarified that the phrase "appropriate customer authorization" refers to the standards EGSs or 3rd parties must meet to gain access to customers' usage information through the Supplier Portal. *See id.* Importantly, **PPL does not propose to develop new standards, but avers that "the conditions for appropriate customer authorization are determined in the Commissions [sic] requirements for licensed EGS's and 3rd parties."** *See id.*

The Commission's current policies provide that "all Electric Distribution Company (EDC) customers shall have the right to withhold all customer account and usage data from the Eligible Customer List that is made available to Commission-licensed Electric Generation Suppliers (EGSs)." Interim Guidelines For Eligible Customer Lists, Final Order On Reconsideration, Docket No. M-2010-2183412 (Nov. 15, 2011), p. 25 (hereinafter "ECL Order") (Emphasis added). To that end, the Commission requires EDCs to publish an Eligible Customer List ("ECL") but allows customers to opt-out of making customer usage data available to EGSs and 3rd parties through the ECL. *See id.*

Unfortunately, **the Commission's current policies rely on an honor system where EDCs are not required to affirmatively review requests for customer data to confirm whether the subject customer has opted out of the ECL**. *See Electric Generation Supplier Access to Restricted Customer Accounts*, Docket No. M-2009-2082042, Secretarial Letter issued August 20, 2010 (hereinafter "EGS Access Letter"). The EGS bears all responsibility for obtaining customer authorization to access usage data and declining to request information for customer accounts that are omitted from the ECL. *See id.* However, **to the extent an EGS possesses customer account information, regardless of the manner of obtaining such information, PPL has no duty to confirm whether the customer opted out of the ECL**. *See* PPLICA Cross- Examination Exhibit No. 2, p. 1. As confirmed by a discovery response from PPL:

The information available to authorized users is not tied to the eligible customer list. It is the obligation of the EGS and 3rd party to ensure they have proper authorization to view customer data.

See id. Particularly as applied to efficient technologies with automated responses, **this policy creates a precarious situation for customers interested in protecting their usage data**.

PPL may have intended to preserve the policies previously developed by the Commission to protect customer data transmitted through EDI, but **the application of the Commission's existing policies to more technically efficient platforms may increase the circulation of customer usage data despite the customer's best efforts to withhold access**. Although the Commission's current customer privacy policies do not require PPL to confirm an EGS's authority to access customer data, the technical limitations of EDI technology require PPL to affirmatively participate in the transaction by responding to each EGS request for customer usage data. *See* PPL Exhibit No. 1, Appendix C, p. 19. To the contrary, **the Supplier Portal automates the process by allowing EGSs, and potentially 3rd parties, to directly access customers' usage data without need for an affirmative response from PPL**. *See id.* Access to the Supplier Portal will be granted to any individual sending an email request from an EGS's email domain and providing the EGS's Licensed PA Energy Provider license information in the email. *See* PPLICA Cross-Examination Exhibit No. 1, p. 4. **Once granted access, the user may obtain usage data for any PPL customer by inputting the customer's PPL account number into the Supplier Portal**. *See id.* at 3. **It does not take much imagination to conjure hypothetical scenarios where an EGS would have access to customer account information but lack authority to access customer data**. For example, unless a customer changes its PPL account

number when switching EGSs, all of its former suppliers would be able to access the customer's current usage data, even if the customer subsequently opts out of the ECL.

Because the usage data available through the Supplier Portal includes sensitive customer information, PPLICA is concerned that the more passive automated access afforded through the Supplier Portal raises the likelihood of unauthorized disclosures of protected customer information. As illustrated below, the Supplier Portal affords access to comprehensive customer usage data:

After appropriate authorization is granted for supplier portal access, **the EGS or 3rd party representative may review and export to excel two years of summary monthly billing data, as well as one year of interval data at the account and meter level**. Two months of paper bill images or six months of electronic bill images are only available to EGS's for the periods in which they were the customer's energy supplier. Also available to EGS's on the supplier portal is a list of customers currently enrolled with the specific EGS.

Additional data available on the supplier portal: eligible customer list, capacity and transmission tags, load profile data, customer rate class, account status, account activation date, net meter indicator, area light indicator, summary billing indicator, and customer bill cycle. This data is consistent with the data provided through EDI.

PPLICA Cross-Examination Exhibit No. 1, p. 2. Although similar to the information provided through EDI, the Supplier Portal increases the ease of access to such information. *See* PPL Exhibit No. 1, Appendix C, p. 19 (identifying increases efficiency as a benefit of the Supplier Portal). **While the improved efficiency would benefit the activities of authorized EGSs and 3rd parties, it would also benefit the activities of less scrupulous EGSs and 3rd parties seeking unauthorized access to customer usage data**.

The potential for abuse of the Supplier Portal necessitates a system for holding users accountable, which PPL has partially addressed by agreeing to maintain event logs of activity through the Supplier Portal. Consistent with informal discussions conducted within the context of PPL's Smart Meter stakeholder process, PPL has incorporated the following automatic recordkeeping capabilities into the Supplier Portal:

An Event Log is maintained and tracks access to customer information based on individual unique user names. Every time a user submits a request for any data available on the portal the request is logged with the unique user name, supplier name, date/time stamp, and customer account number and recorded as successful or unsuccessful attempts.

See PPLICA Cross-Examination Exhibit No. 1, p. 5. PPL has further confirmed that the event log data will remain accessible for three years. *See id.* at 7-8. Additionally, PPL has indicated that it will furnish event log data upon request of either PUC staff or customer representatives. *See id.* at 8. Unfortunately, PPL's responses to discovery questions also indicated that requests for customer event log data will be reviewed on a case-by-case basis. *See id*. at 8. While PPL later clarified that its ability to respond to customer requests for event log data would likely be constrained only by the timeframe of a customer's request, **the fact remains that an *ad hoc* process for addressing such requests is insufficient**. *See* Tr. 59-60. To more adequately provide customers with a resource to monitor data requests through the Supplier Portal, PPL must be directed to develop specific protocols setting forth the limitations on its ability to respond to customer requests for event logs. Absent compelling reasons, requests should be fulfilled without undue delay.

Moreover, while the availability of event log data provides both the PUC and customers with a degree of oversight over the operation of PPL's Supplier Portal, additional action is required to fulfill the policy goals set forth in the Commission's ECL Order. As stated above, the ECL Order granted all customers the right to withhold usage data from the ECL made available to EGSs. *See* ECL Order, p. 25. As EDCs transition from EDI towards more efficient automated databases, **the Commission should consider whether more affirmative restrictions on EGS or 3rd party access to customer access should be implemented to minimize the potential for unauthorized disclosures of customer usage data**. While PPL's recordkeeping policies, as modified by PPLICA's recommendation to add specific protocols outlining the evaluation process for customer event log requests, would impose some accountability upon EGSs and 3rd parties using the Supplier Portal, **the burden for policing unauthorized access remain primarily with the customer**. **This passive enforcement structure severely erodes the security and protection afforded to customers choosing to opt-out of the ECL**. **Further Commission action to investigate and update the Commission's customer privacy policies is necessary to provide appropriate protection for customers wishing to withhold usage information from dissemination to unauthorized EGSs or 3rd parties**.

[PPLICA Main Brief - End quote] (Underlining and emphasis added.)

EXHIBIT 51W (FD):
Office of Small Business Advocate (OSBA) Main Brief RE: *PPL Petition for Approval of its SMP* (Docket No. M-2014-2430781) (Jan. 13, 2015). Reads in part:

[OSBA Main Brief - Begin quote]

VI. Argument

...

H. Cyber Security Issues

...

The following exchange took place between the OSBA attorney and PPL witness Kent Simendinger:

...

Q: Well, as anyone who reads the news today, you hear about companies being hacked by various groups nationally and internationally. So, what kind of data -- and if we need to go on the proprietary record, that's fine -- **what kind of data is currently at risk?** For example, personal information, customers' credit card information, bank account information, social security?

A: The current information from a customer standpoint has to do with the basic information. **PII, personally identified information**, might include their **name, address, account numbers**, that sort of thing, **as well as their usage data**.

Q. And would you say if it's at risk today, whatever threat level you assign that, **is it going to be somewhat less at risk with the new Smart Meters, significantly less at risk**? Give us some idea how – how unsafe we are today and how safe we will be, from PPL's standpoint.

A. **I could never say we're fully safe**, but I can say that the features that are offered from how I understand the technology are better able to transmit and detect and monitor for anomalous behaviors. So, that would put us in a better position. **I can't say if it's significant or less significant**. ...

Transcript, at page 102, line 14, through page 104, line 18.

ALJ Colwell and the Commission can take judicial notice of the fact that the "hacking" of computer systems and cyber attacks are being reported regularly in the news. Recent hacks that have made the news would pale in comparison to a scenario where a terrorist organization is able to penetrate the RF Mesh proposed by PPL in this proceeding.

The OSBA is cognizant that, at the time of this writing, there is no "magic bullet" to solve all the issues surrounding cyber security. ... **The fact that Mr. Simendinger cannot provide a quantitative answer as to whether the new smart meters would provide significantly more protection from hackers ... simply illustrates how complex and difficult this problem is**.

[OSBA Main Brief - End quote] (Emphasis added.)

EXHIBIT 51X-1 (FD):
Electronic Data Exchange Working Group (EDEWG) *PA Web Portal Working Group Solution Framework* Proposal (Docket No. M-2009-2092655) (Feb. 23, 2015). Reads in part:

"**The EDC cannot and therefore will not attempt to detect whether an individual user is accessing the portal with the appropriate user ID**." (p. 6.)
...
"2.1.3 Customer Privacy

a. Prior **PaPUC regulatory mandates require that the EDC make this data available to EGSs and place the burden of customer authorization on licensed EGSs and their agent**s ... .

b. **The web portal will adhere to the privacy standards mandated by the PaPUC regardless of the customer's preference for release of information on file with the EDC**." (p. 7.)
...
2.3.12. **Data elements available to users** in the downloadable file format for accepted account-level requests **must include** the following:

a. **Customer identifier**
b. **Customer name**
c. Report title (Account-Level Usage or Meter-Level Usage)
d. **EDC name**
e. **Premise (corresponds to a specific physical location)**
f. Service Point (corresponds to a specific electric service)
g. **Meter Number**
h. Meter Manufacturer (name)
i. Meter Multiplier
j. Usage start and end dates (encompass all data provided in report)
k. Peak Load Contribution, kWh (PLC, also known as "capacity obligation") ...
l. Network Service Peak Load, kWh (NSPL, also known as "transmission obligation") ...
m. Rate Class
n. Rate Subclass
o. Bill Cycle
p. Load Profile
q. Special Meter Configuration (currently indicates net metered status)
r. **A minimum of the 12 most recent billed periods of meter-level monthly summary usage, aka consumption or kWh**, with the most recent data first (p. 10.)

(Underlining and emphasis added.)

EXHIBIT 51X-2 (FD):
ALJ Initial Decision RE: *PPL Petition for Approval of its Smart Meter Technology and Procurement Installation Plan* (Docket No. M-2014-2430781) (April 20, 2015). The decision, in which the ALJ acknowledges and states abbreviated privacy and security concerns of OCA, CAUSE-PA, PPLICA and OSBA, reads in part:

[Initial decision: PPL petition for approval of SMIP - Begin quote]

III. FINDINGS OF FACT

...
7. The Company's present system was one of the first to be installed which provided automated meter reading by communicating through the power lines. PPL Electric can read its meters on an hourly, daily or monthly basis. PPL Electric Stmt. 1 at 5; PPL Stmt. Electric 2 at 4.
...
10. The existing system is a Power Line Carrier (PLC) metering system. PPL Electric Stmt. 1 at 6.
...
15. Approximately 86% of the total existing meters are 2002 vintage electromechanical meters retrofitted with a first generation PLC communication module. PPL Electric Stmt. 2 at 8.
...
21. Meters installed according to this SMTP will have the following capabilities:

Bidirectional data communications;
...
Support of Time-Of-Use (TOU) and Real-Time-Pricing (RTP);

Ability to provide 15-minute **or shorter** interval data to customers, EGS's, third-parties, and an RTO on a daily basis, consistent with the data availability, transfer, and security standards adopted by the RTO.

Remote Service Switch capability;

On-board Meter Storage of meter Data that complies with the nationally-recognized non-proprietary standards;
...
Ability to upgrade as technology advances and becomes economically feasible;

Remote programming capability;

...
PPL Electric Stmt. 2 at 12-13.
...
33. The proposed system is a Radio Frequency Mesh system comprised of **Zigbee enabled meters to support in-premise communications** and field devices leveraging both public networks and PPL Electric's network for the Wide Area Network backhaul. PPL Electric Stmt. 3 at 5.
...

IV. DISCUSSION

...

H. CYBERSECURITY ISSUES

...

OSBA

OSBA cites the testimony of PPL Witness Simendinger at the hearing, when he responded to questioning regarding whether the proposed system will provide significantly more security for customer information than the existing system already does:

> The OSBA is cognizant that, at the time of this writing, there is no "magic bullet" to solve all the issues surrounding cyber security. Nevertheless, PPL is proposing an extremely expensive upgrade to its existing smart meter system. **The fact that Mr. Simendinger cannot provide a quantitative answer as to whether the new smart meters would provide significantly more protection from ... simply illustrates how complex and difficult this problem is**.

...
OSBA MB at 30.
...

Disposition

PPL Electric has sustained its burden of establishing that the SMP contains a cybersecurity plan that is reasonable and sufficient to deal with the concerns raised by a metering system that is heavily dependent on potentially vulnerable systems.
...

I. DATA PRIVACY ISSUES

1. General

...

OCA

OCA points out that the protection of customers' personal and usage data must be a critical component of a Smart Meter Plan. The SMP at 35-42 addresses the proposal.

OCA Witness Brockway states that the SMP does not address the unique challenges of customer privacy resulting from the deployment of smart meters, summarizing as follows:

I reviewed the privacy policies of PPL Electric that I could find, and showed their limitations from a SMP perspective. I recited that PPL Electric intends to address privacy issues with an engineering group, who will not be aware of the privacy concerns from the customer perspective. I noted that the Company makes no mention of Green Button privacy issues in its SMP or elsewhere. **I concluded that PPL either does not yet have a sense of what information its customers might like it to protect as private, or has not fully described its approach to privacy in the SMP.** I also concluded that PPL considers privacy a sub-set of cyber-security, rather than a topic that needs to be addressed on its own terms. **The Company's SMP as written is unlikely to lead to privacy policies that address customers' desire for privacy in an advanced metering world**.

OCA Stmt. 3-S at 7 (Citations omitted).

OCA MB at 45-56.

OCA recommends that the Company be required to revise the privacy components of its SMP, and that it do so with the assistance of employees well-versed in customer service issues, and of stakeholders who are able to communicate various consumers' desires for privacy.

CAUSE-PA

CAUSE-PA avers that the current policies of PPL Electric were developed to coordinate with its present system, and that **the simple application of these existing policies are insufficient to protect customer information obtained under the proposed SMP**. CAUSE-PA looked at the current website and noted that **PPL Electric reserves the right for <u>using the energy, technical and reference information it collects, in aggregate or individual form for</u>**:

...

- **Promotion**
- **Advertising**

...

- **Statistical analysis**

...

- **Marketing**

...

The Privacy Notice also leaves open the possibility that PPL may "rent, license, or sell Personal Information, defined as "including the customer's name, address, password, home service, domain and email address, transaction, billing and payment history, and usage, among other things, to third parties." CAUSE-PA MB at 18-19.

Therefore, a customer who accesses the PPL Electric website to pay a bill or to use the Energy Analyzer to manage usage exposes their smart meter data to broad disclosure under the present privacy notice. Given that the new information will be available under the new SMP, it only stands to reason that a new privacy policy should be implemented.

...

2. Supplier Portal Issues

PPLICA

PPLICA does not oppose the SMP but requests that approval be conditioned on further refinements to two components of PPL's Plan.

The SMP contains the proposal to implement a Supplier Portal for purposes of facilitating EGS and third-party access to customer usage data. **PPLICA avers that the customer usage data will remain at risk absent additional Commission action to refine current policies placing the burden of monitoring access to customer usage data on the customer**.

The purpose of the proposed portal is to provide access directly without need for an EDI request and response. Access will be permitted if the EGSs or third parties meet the standards set.

Presently, customers are permitted to opt out of allowing EDCs to share their information with EGSs and third parties. However, **presently the EDCs do not affirmatively review requests for customer data to confirm whether the customer had opted out, and the EGS bears responsibility for asking for the appropriate data**. PPLICA MB at 5.

The Supplier Portal increases the ease of access to customer information, such as two years of summary monthly billing data, a year of interval data at the account and meter level, two months of paper bill images, and a list of customers currently enrolled with the specific EGS. Also available is the eligible customer list, capacity and transmission tags, load profile data, customer rate class, account status, account activation date, net meter indicator, area light indicator, summary billing indicator, and customer bill cycle. PPLICA MB at 7, citing PPLICA Cross-Examination Exhibit No. 1 at 2.

PPL Electric's oversight consists of granting the original access to an EGS or third party, and the maintenance of an event log. PPLICA submits that this is insufficient to properly protect customer information.

CAUSE-PA

CAUSE-PA argues that the Commission must direct PPL Electric to revise its policy regarding the Supplier Portal in a manner which provides actual protection from dissemination of information of customers who have opted out:

In accordance with guidance and direction from the Commission, PPL adopted a Supplier Portal to make information available to suppliers. However**, the Supplier Portal goes far beyond providing access to customer information, and allows electric generation suppliers nearly unfettered access to extremely sensitive personally identifying information, including the customer's Social Security number and detailed usage data, without obtaining verification of customer consent. As PPL explained, "[t]o search for an account number, the EGS or 3rd party must know the name of the customer as it appears on the customer's PPL electric bill at a minimum." And, once the customer's name is supplied (or, if the name is not known, the phone number, Social Security Number, e-mail address, meter number, or premises address), an EGS or 3rd party can access a plethora of personal information, including the customer's Social Security Number.** After providing the customer's name, the EGS or third party must self-certify that they have the customer's authorization and that they have verified the customer's identification. But, to put those added self-certification requirements in context, **the sole protection that these self-certifications rest alone on in the "integrity" of the EGS or the 3rd party, without any verification by PPL to ensure that their customer's information is protected**.

At the final hearing, it was further revealed that "the customer's designation of their data as confidential or nonconfidential does not affect the EGS or third party's ability to access customer data through the supplier portal. So, not only is the information easy to access, it is also impossible to protect from dissemination. And, once information is disseminated, the harm is difficult for a customer to remedy or ameliorate.

* * *

Essentially, the Supplier Portal undermines and effectively thwarts any attempt by PPL to address personal data privacy through the creation of a robust policy and detailed protocols and procedures because it creates a shortcut for an unknown number of individuals to access highly sensitive data, leaving the system vulnerable to widespread and irremediable abuse.
CAUSE-PA MB at 20-21(citations omitted).

The Company's response was to state that "the burden is on the EGS and/or third party to ensure that they have the appropriate authority," and that PPL Electric maintains a log of such access. The Company states that it follows applicable Commission guidance with respect to the Supplier Portal, and that changing Commission policies with regard to one EDC is inappropriate.

Disposition

The Company already has policies in place which it will adapt to cover the new concerns which arise with the technology upgrade in the proposed RF Mesh system. **The Company rejects any suggestion that they consult with stakeholders and reevaluate its plan with the new abilities in mind.** However, **it is the lack of detail in the plan itself that raises the concerns expressed by the OCA and CAUSE-PA. The Company will be required to develop a stand-alone customer privacy policy specifically related to the protection of smart meter information before the deployment of the smart meters.** It will be directed to confer with stakeholders in developing the new policy and during the educational process described in its SMP.

Regarding the Supplier Portal, the Company states that it follows Commission guidelines and policies. However, it provides no citations or support for those statements, and thus, it is not possible to know which Commission guidance and/or policies the Company purports to follow. Accordingly, this statement is given no weight, and the Company has not sustained its burden of proving that this portion of the SMP is reasonable. Commission initiatives, however, will determine the Company's ultimate actions in this subject.

While PPLICA's and CAUSE-PA's request that the Company revise its policy and procedure regarding access to the Supplier Portal to enable customers to protect their information from inclusion in the Supplier Portal and to require verification of EGS certifications is reasonable, the Company will be bound by a Commission initiative presently underway. The electronic data exchange working group (EDEWG) convened a web portal working group (WPWG) to develop standardized solutions for the acquisition of both the historical interval usage (HIU) and billing quality interval use (IU) data via a secure web portal, under Commission Order entered December 6, 2012, in this docket. On February 17, 2015, **a final version of the document titled "Pennsylvania Web Portal Working Group Solutions Framework" was filed, which purportedly outlines the portal solution that would permit third parties such as EGSs and Conservation Service Providers (CSPs) to acquire data within 48 hours of daily meter reads**. Commission review of this document will occur at a public meeting. The outcome of this proceeding will likely determine the direction of this issue.

Ideally, the Commission's scrutiny will result in regulations, which are the appropriate way to implement a statute. The parties' failure to mention the ongoing Commission initiative is understood because a search of the Commission's regulations would not result in finding them. Rather, the process is one that the Commission uses when the directions in a new statute require Commission guidance before regulations can be promulgated, and where the Commission institutes a regulatory process afterwards to ensure the due process rights of all involved.

In the meantime, the Company will be expected to comply with whatever outcome that the EDEWG recommends and the Commission approves at Docket No. M-2009-2092655, and there appears to be a recommendation pending at this time. The Commission's Final Order in that matter may be available to provide guidance for the disposition of this issue by the time the Commission issues its Final Order in the present case, but it is not available at this time. Accordingly, the parties who seek to be involved in the development of that process should look to that docket, and that the Company develop its Plan in accordance with Commission guidelines.

...

V. CONCLUSION

The SMP Petition of PPL Electric is granted and its SMP amended as indicated in the Ordering Paragraphs below.

VI. CONCLUSIONS OF LAW

...

4. Electric distribution companies shall, with customer consent, make available direct meter access and electronic access to customer meter data to third parties, including electric generation suppliers and providers of conservation and load management services. 66 Pa.C.S.A. § 2807(f).

7. The *Implementation Order* directs that the EDC's smart meter technology support the following capabilities:

Specifically, we direct that the plan filing shall quantify the costs to deploy and operate smart meter technology that is capable of the following minimum requirements set forth in 66 Pa.C.S. § 2807(g):

...

- Supporting the **automatic control of the customer's electric consumption**.

In addition, each plan filing shall include the individual incremental costs for deploying and operating the following smart meter technology capabilities:

- Ability to remotely disconnect and reconnect.

- Ability to provide 15-minute **or shorter** interval data to customers, **EGSs**, **third-parties** and an RTO on a daily basis, consistent with the data availability, transfer and security standards adopted by the RTO.

- On-board meter storage of meter data that complies with nationally recognized non-proprietary standards such as ANSI C12.19 and C12.22 tables.

...

- **Ability to upgrade these minimum capabilities as technology advances** and becomes economically feasible.

- Ability to monitor voltage at each meter and report data in a manner that allows an EDC to react to the information.

- **Ability to remotely reprogram the meter**.

...

Implementation Order at 16-17.

...

VII. ORDER

...

1. That **the Petition of PPL Electric Utilities Corporation for Approval of its Smart Meter Technology Procurement and Installation Plan**, filed at Docket No. M-2014-2430781, **is approved as modified by these Ordering Paragraphs**.

...

7. That PPL Electric Utilities Corporation shall file a stand-alone Customer Privacy Policy before any wide scale deployment of smart meters. The stand-alone Customer Privacy Policy shall also be served upon the Reliability and Emergency Preparedness Section of the Commission's Bureau of Technical Utility Services.

...

9. That PPL Electric Utilities Corporation shall develop its customer and supplier portals in accordance with the statutes, regulations and orders administered by the Pennsylvania Public Utility Commission.

[Initial decision: PPL petition for approval of SMIP - End quote] (Underlining and emphasis added.)

EXHIBIT 51Y-1 (FD):

PA PUC Order RE: *PPL Petition for Approval of its Smart Meter Technology and Procurement Installation Plan* (Docket No. M-2014-2430781) (Entered: Sept. 3, 2015). The EDEWG's Web Portal Working Group (WPWG) *Solution Framework*

was available to the Commission prior to this decision, which reads in part:

[PUC order: PPL Petition for Approval of its SMP - Begin quote]

... For the reasons discussed below, we shall grant, in part, and deny, in part, the Exceptions of PPL, and shall deny the Exceptions of the OCA, OSBA and PPLICA. We shall also adopt the ALJ's Initial Decision, as modified, consistent with our discussion of the issues presented herein.

V. Contested Issues

...

I. Data Privacy Issues

1. Positions of the Parties

The OCA contended that PPL's SMP does not adequately address customer data privacy issues. The OCA asserted that the SMP does not provide the types of privacy risks that PPL anticipates from implementation of the SMP. The OCA further asserted that PPL's privacy policy relates only to personal data accessible through the Company's website, and does not extend to data obtained in other ways, such as over the phone, by mail, or through the customer's smart meter. Therefore, the OCA recommended that PPL be required to develop a stand-alone customer privacy policy relating to its smart meter technology that uses customer service employees as part of its smart meter team, and that utilizes the input of stakeholders. OCA M.B. at 45-48. ...

PPLICA supported the OCA's proposal that PPL be required to further examine and refine its data privacy policy through a stakeholder process. PPLICA R.B. at 5-6. **In addition, PPLICA expressed concern regarding the privacy of customer usage data that will be available to electric generation suppliers (EGSs) and third parties through the supplier portal that PPL is proposing to implement as part of its SMP**. PPLICA noted that EDCs are required to allow customers the option to withhold the disclosure of all customer account and usage information from the Eligible Customer List (ECL) through an opt-out process. PPLICA M.B. at 5 (citing *Interim Guidelines for Eligible Customer Lists*, Docket No. M-2010-2183412 (Final Order on Reconsideration entered November 15, 2011) at 25). However, **PPLICA stated that EDCs are not required to affirmatively review EGS requests for customer data to confirm whether the customer has opted out of the ECL**. PPLICA M.B. at 5 (citing *Re: Generation Supplier Access to Restricted Customer Accounts*, Docket No. M-2009-2082042 (Secretarial Letter issued August 20, 2010) (*August 2010 Secretarial Letter*)). Furthermore, **PPLICA argued that the supplier portal will allow EGSs and third parties to access customer data without the need for an affirmative response from the EDC**, as is necessary under the current Electronic Data

Interchange (EDI) technology. Thus, **PPLICA contended that an EGS or third party may easily gain access to customer usage data without having the authority to do so**. PPLICA M.B. at 6-7.

PPLICA stated that PPL has partially addressed this problem by agreeing to maintain event logs of activity through the supplier portal, and providing data from the event logs to customers who request it. However, PPLICA asserted that PPL must be directed to develop specific protocols regarding its response to such requests, stating that "[a]bsent compelling reasons, requests should be fulfilled without undue delay." *Id*. at 8. In addition, **PPLICA submitted that the Commission should investigate and update its privacy policies to impose more affirmative restrictions on access to customer data** as EDCs transition from EDI to more automated databases, such as PPL's supplier portal. *Id*. at 9.

CAUSE-PA also expressed concern regarding the privacy of customer data, arguing that PPL's existing privacy policy is overly broad, and does not adequately address additional privacy risks that may arise in connection with smart meter technology. Accordingly, CAUSE-PA recommended that PPL be required to revise its SMP to include a specific and detailed data privacy plan, in consultation with interested stakeholders. CAUSE-PA M.B. at 17-20. In addition, **CAUSE-PA echoed PPLICA's concern that EGSs and third parties will have easy access to customer data through PPL's supplier portal, and that PPL has no obligation to verify that the EGS or third party has the customer's authorization to access this data**. *Id*. at 20-21.

PPL responded that it follows all Commission Regulations regarding the privacy of customer data, and that it is not necessary for it to revise the privacy components of its SMP, or to develop a stand-alone privacy policy that is separate from its cybersecurity plan, as the OCA contended. PPL M.B. at 39-40. In addition, PPL asserted that holding a collaborative with interested stakeholders regarding privacy issues is also unnecessary, and would increase customer costs and unreasonably interfere in the management of the Company. PPL R.B. at 34. **PPL averred that its SMP outlines all necessary components of data privacy**. *Id*. (quoting PPL St. No. 5-RJ at 3-4).

With regard to the availability of customer data through its supplier portal, PPL asserted that it follows applicable Commission policies, which apply to all EDCs. PPL argued that a change in these policies should not be made in the instant proceeding, but should be addressed in a generic proceeding where all utilities have the opportunity to comment. PPL R.B. at 35. As for PPLICA's concerns regarding customer requests for event logs, PPL stated that it will attempt to respond to such requests within ten days, and that it will provide the information absent unusual circumstances. PPL asserted that it cannot develop more specific procedures at this

time as PPLICA recommended because the Company has not had any customer requests for event logs and cannot predict all circumstances that may arise. PPL stated that it would address any issues in this regard on a case-by-case basis. *Id*. at 36.

2. ALJ's Recommendation

The ALJ agreed with the OCA and CAUSE-PA that PPL's SMP lacks sufficient detail with regard to the privacy of customer data as it relates to smart meter technology. Accordingly, the ALJ determined that PPL should be required to develop a stand-alone customer privacy policy specifically related to the protection of smart meter information before the Company deploys its new smart meters. The ALJ further determined that PPL should be required to confer with stakeholders in developing the new policy. I.D. at 61. The ALJ directed that PPL also serve the stand-alone privacy policy on the Reliability and Emergency Preparedness Section of the Commission's Bureau of Technical Utility Services. *Id*. at 72.

With regard to the supplier portal issues, the **ALJ stated that PPL provided no citations or support for its assertion that it follows Commission guidelines and policies regarding access to customer data through the supplier portal**. Thus, the **ALJ asserted that it is not possible to know which Commission guidance and/or policies the Company purports to follow**. Accordingly, the **ALJ found that PPL did not sustain its burden of proving that this portion of its SMP is reasonable**. **However, rather than requiring PPL to revise its policy and procedures regarding access to the supplier portal and the protection of customer data as PPLICA and CAUSE-PA proposed, the ALJ found that PPL should be bound by the Commission's final determination in a separate proceeding currently pending before the Commission relating to the acquisition of data via a secure web portal**. I.D. at 61-62; *See Submission of the Electronic Data Exchange Working Group's Web Portal Working Group's Solution Framework for Historical Interval Usage and Billing Quality Interval Use*, Docket No. M-2009-2092655 (Tentative Order entered April 23, 2015) (*WPWG Proceeding*). In this regard, the ALJ stated as follows:

The electronic data exchange working group (EDEWG) convened a web portal working group (WPWG) to develop standardized solutions for the acquisition of both the historical interval usage (HIU) and billing quality interval use (IU) data via a secure web portal, [pursuant to the *December 2012 SMP Order*]. **On February 17, 2015, a final version of the document titled "Pennsylvania Web Portal Working Group Solutions Framework" was filed, which purportedly outlines the portal solution that would permit third parties such as EGSs and Conservation Service Providers (CSPs) to acquire data within 48 hours of daily**

meter reads. Commission review of this document will occur at a public meeting. The outcome of this proceeding will likely determine the direction of this issue.

Id. at 62.

The ALJ asserted that ideally, the Commission's scrutiny of this matter will result in regulations, "which are the appropriate way to implement a statute." *Id*. In the meantime, the **ALJ stated, PPL will be expected to comply with whatever outcome the Commission approves in the *WPWG Proceeding***. Thus, the ALJ recommended that parties that wish to be involved in the development of a solution regarding access to customer data via the supplier portal should look to that proceeding, and PPL should develop a plan in accordance with the resulting Commission guidelines. *Id*.

3. Exceptions and Replies

In its Exception No. 1, PPLICA asserts that the ALJ erred in her finding that the privacy issues it raised regarding the supplier portal would be better addressed in the *WPWG Proceeding* than in the instant proceeding. PPLICA argues that while the *WPWG Proceeding* may address data privacy issues to a limited degree, its primary focus is on the adoption of technical standards for EDC web portals, and will not speak to the specific concerns raised by PPLICA in this proceeding. PPLICA avers that it will participate in the *WPWG Proceeding* and file comments to the Commission's Tentative Order in that proceeding, but contends that the Commission must rule on PPL's supplier portal in the instant proceeding, and should address PPLICA's concerns. PPLICA Exc. at 2-5.

In reply, PPL asserts that it is completely reasonable for the Commission to address data privacy issues in the generic *WPWG Proceeding* because such issues can affect every EDC in Pennsylvania. Moreover, PPL repeats that it cannot develop specific protocols regarding access to event log data as PPLICA recommends because the Company has not had any customer requests for event logs and cannot predict all circumstances that may arise. PPL R. Exc. at 18. In addition, **PPL asserts that the Commission has previously determined that EGSs are not required to provide prior documentation to EDCs regarding their authorization to receive customer data**. *Id*. at 18-19 (citing *August 2010 Secretarial Letter*). **PPL submits that if an EGS obtains customer information without the proper authorization, the customer can address the matter by filing a complaint with the Commission. PPL states that it should not be required to police EGS activity**. PPL R. Exc. at 19.

4. Disposition

We will adopt the ALJ's recommendation that PPL be directed to work with interested stakeholders to develop a stand-alone customer privacy policy specifically related to the protection of smart meter information before any wide-scale deployment of its RF Mesh system. This is consistent with our determination with regard to the FirstEnergy Companies' SMP. *See March 2014 FirstEnergy SMP Order* at 47. We further direct that PPL serve the stand-alone privacy policy on the Reliability and Emergency Preparedness Section of the Commission's Bureau of Technical Utility Services.

With regard to the privacy of customer data accessible through the supplier portal, we believe that PPLICA's concerns are substantially addressed by PPL's intention to provide event logs of supplier portal activity within ten days of a customer request, absent unusual circumstances. However, to the extent that any uncertainty exists regarding the limitations of PPL's ability to comply with such requests, we recommend that this issue be addressed during the stakeholder discussions, and that any resolution of the issue be included as part of PPL's stand-alone privacy policy. In addition, **we agree with the ALJ that further concerns regarding the privacy of data accessible through a secure web portal can be adequately addressed in the *WPWG Proceeding***.[2] Accordingly, **we will deny the Exceptions of PPLICA on this issue**.

...

[2] We note that this issue was, in fact, raised in the *WPWG Proceeding* in the collective Comments of the Industrial Customer Groups, which included PPLICA, filed on May 26, 2015 in that proceeding.

...

VI. Conclusion

In accordance with the above discussion, **we shall grant, in part, and deny, in part, the Exceptions of PPL, and deny the Exceptions of the OCA, OSBA, and PPLICA**. In addition, we shall adopt the ALJ's Initial Decision, as modified, consistent with this Opinion and Order; **THEREFORE,**

IT IS ORDERED:

1. That the Exceptions of PPL Electric Utilities Corporation are granted, in part, and denied, in part, consistent with this Opinion and Order.

2. That **the Exceptions of the Office of Consumer Advocate are denied**, consistent with this Opinion and Order.

3. That **the Exceptions of the Office of Small Business Advocate are denied**, consistent with this Opinion and Order.

4. That **the Exceptions of the PP&L Industrial Customer Alliance are denied**, consistent with this Opinion and Order.

5. That the Initial Decision of Administrative Law Judge Susan D. Colwell is adopted, as modified, consistent with this Opinion and Order.

6. That **the Petition of PPL Electric Utilities Corporation for Approval of Its Smart Meter Technology Procurement and Installation Plan is granted, in part, and denied, in part**, consistent with this Opinion and Order.

7. **That the Smart Meter Technology Procurement and Installation Plan filed on June 30, 2014 by PPL Electric Utilities Corporation in the above-captioned proceeding is adopted as modified by this Opinion and Order**.

...

9. **That PPL Electric Utilities Corporation is permitted to implement the deployment schedule proposed in its Smart Meter Technology Procurement and Installation Plan** filed on June 30, 2014 in the above-captioned proceeding.

...

14. That PPL Electric Utilities Corporation shall develop its customer and supplier portals in accordance with the Statutes, Regulations and Orders administered by this Commission.

[PUC order: PPL Petition for Approval of its SMP - End quote] (Underlining and emphasis added.)

EXHIBIT 51Y-2 (FD):

PPL comments on *Submission of the Electronic Data Exchange Working Group's Web Portal Working Group's Solution Framework for Historical Interval Usage and Billing Quality Interval Use* (Docket No. M-2009-2092655) (May 26, 2015). Page 7 reads in part:

"PPL Electric is concerned that **the Tentative Order could be construed to mean that non-licensed entities should be permitted access to customer data through the EDCs' web portals**. ... **It is unclear to what extent the Commission would have jurisdiction to resolve disputes or issues related to non-licensed third parties seeking customer data through EDCs' web portals**. Further, **EDCs should not be responsible or liable for policing whether non-licensed third parties have obtained customer consent for release of the customer data**." (Emphasis added.)

EXHIBIT 51Y-3 (FD):
Electronic Data Exchange Working Group (EDEWG) *PA Web Portal Working Group Technical Implementation Standard* for:

System to System - Historical Interval Usage (StS-HIU) (Docket No. M-2009-2092655) (April 7, 2016),

System-to-System Rolling 10-day Billing Quality Interval Usage (StS-Rolling 10-Day BQIU) (Docket No. M-2009-2092655) (April 7, 2016), and

Single User - Multiple Request (SU-MR) (Docket No. M-2009-2092655) (April 7, 2016).

The three documents named in this exhibit were submitted to the Commission under a single cover. With regard to customer privacy and portal user eligibility, each of these three EDEWG documents contains virtually identical language which reads:

[EDEWG WPWG Implementation Standard - Begin quote]

1.1. Certification, Access, and Customer Privacy
1.1.1. Portal user eligibility
...
iii. **Unlicensed subcontractors or agents of licensed EGSs**, such as Electronic Data Interchange (EDI) and billing providers, **are eligible to receive access to the web portal** on behalf of licensees that they represent, but their use must be directly associated with those licensees under the assumption that users are only accessing the portal in support of service to a specific licensed entity. For example, a provider obtaining usage for an account on behalf of fictitious supplier "ABC Energy" must be logged in such that the "ABC Energy" licensee is associated with and held accountable for associated use of the portal by that provider on ABC Energy's behalf.
...
iv. The capability for other **3rd parties (entities not licensed by the PaPUC as EGSs)** to access this information is outside the scope of the WPWG effort. Such entities are NOT eligible for access to the web portal and must **obtain customer data via other means**.

1. **Alternative means of obtaining customer data include** contacting the customer directly or - **at the discretion of the EDC - submitting requests to the EDC accompanied by proper Letters Of Authorization, or "LOAs"** (i.e. Duquesne's current process).
...

1.1.3. Customer Privacy

a. Prior **PaPUC regulatory mandates require that the EDC make this data available to EGSs and place the burden of customer authorization on licensed EGSs and their agents**, who are subject to PUC audit for the same.

b. **The Web Portal will adhere to the privacy standards mandated by the PaPUC regardless of the customer's preference for release of information on file with the EDC**.

...

Data elements available to users in the downloadable file format for accepted account-level requests **must include** the following:

a. **Customer identifier** (EDC account number is an example)
b. **Customer name**
c. Report title (Account-Level Usage or Meter-Level Usage)
d. **EDC name**
e. **Premise (corresponds to a specific physical location)**
f. Service Point (corresponds to a specific electric service)
g. **Meter Number**
h. Meter Manufacturer (name)
i. Meter Multiplier
j. Usage start and end dates (encompass all data provided in report)
k. Peak Load Contribution, kWh (PLC, also known as "capacity obligation") ...
l. Network Service Peak Load, kWh (NSPL, also known as "transmission obligation") ...
m. Rate Class
n. Rate Subclass
o. Bill Cycle
p. Load Profile
q. Special Meter Configuration (currently indicates net metered status)
r. Detailed account-level interval usage data **A minimum of the 12 most recent billed periods of meter-level monthly summary usage, aka consumption or kWh**, with the most recent data first
s. A **minimum of the 12 most recent billed periods of meter-level monthly demand, aka kW**, with the most recent data first ...

[Note: The "**data elements available to users**" in the immediately preceding list reflect the 'StS-Rolling 10-Day BQIU' and 'SU-MR' protocols set forth in the EDEWG *Implementation Standard*.]

[EDEWG WPWG Implementation Standard - End quote] (Underlining and emphasis added.)

EXHIBIT 51Y-4 (FD):

PA PUC Final Order RE: *Submission of the Electronic Data Exchange Working Group's Web Portal Working Group's Solution Framework for Historical Usage and Billing Quality Interval Use* (Docket No. M-2009-2092655) (Entered: June 30, 2016). Contains the Commission's order:

"That **the Electronic Data Exchange Working Group's *Pennsylvania Web Portal Working Group Technical Implementation Standards* are hereby approved, as submitted**." (Emphasis added.)

EXHIBITS 51Z-1, 51Z-2 and 51Z-3 (FD):
This sequence of screenshots displays the "Privacy Release Status History" for our PPL account on PPL's website.

EXHIBIT 51Z-1 displays three (3) entries under "Privacy Release Description" and a "Date Received" corresponding to each of the three privacy release description entries.

60. Despite the fact that we **never** have given permission, orally or in writing, to PPL to release, for any reason or purpose, our personal information, the phrase: "OK to Release All," is displayed corresponding to "2015-03-04" as the "Date Received." There was one occasion, however, in which we did return a written form to PPL, explicitly indicating to PPL that the company was **not** to release our information to any third party. We assume that that request is reflected by the initial "Withhold All" description corresponding to the "2015-03-18" date received.

On "2017-12-19," the Privacy Release Description somehow was reset to "OK to Release All" as the "Current Selection." This change originated with PPL alone, and it is PPL which is entirely responsible for having made it. We absolutely **did not authorize this change**. In fact, we had never visited PPL's website prior to our discovery of this matter on January 21, 2018, when we immediately acted to restore the privacy release description to "Withhold All." Our action to correct the matter is reflected in the screenshot displayed in **EXHIBIT 51Z-2**, and the effect of that change to the "Privacy Release Description" is displayed in the screenshot in **EXHIBIT 51Z-3**.

61. The message displayed in the screenshot in **EXHIBIT 51Z-2** states: "PPL updates its customer list for suppliers during the third week of every month. Your selection will be reflected in the next scheduled update." This means that, **without our knowledge and consent**, our account information had been available to third parties initially between "2015-03-04" and "2015-03-18," which was a period of two weeks, and depending on the time of the earliest subsequent update by PPL, the total period could have been as long as six weeks. It also means that, **not only**

without our knowledge and consent, but **directly contrary to our expressed written request**, our account information had been made available **for a second time** to third parties for a period of approximately two months. That is, from "2017-12-19" to sometime in the third week of February, 2018.

62. **The action by PPL,** described in assertions 60 and 61, supra, **whether intentional or inadvertent, constitutes mismanagement and abuse of our PPL account information and a breach of our privacy**.

For PPL to claim that the company "takes customer privacy ... very seriously," such information mismanagement and blatant breaches of customer privacy and confidentiality are utterly unacceptable and render PPL's claim highly questionable. If PPL does not, cannot or will not properly manage simple selection indicators on its own website or in its customer accounts database, there is no way that we can, or should, ever trust that the company will properly and completely secure the confidentiality of our personal and private data as a whole, especially when the granular data collected and transmitted by PPL's wireless smart meter devices through its mesh network is orders of magnitude more complex and would contain far more information that could be exceedingly invasive of the privacy of our home.

63. Our experience with PPL's mishandling and abuse of our individual account information notwithstanding, the OCA, PPLICA, CAUSE-PA, and OSBA all have expressed fundamental concerns about PPL's smart meter implementation plan, **pointing to various serious flaws and weaknesses in that plan with regard to customer data security and privacy**.

64. However, rather than having resolved the formidable problems and concerns expressed by OCA (**EXHIBIT 51T**), PPLICA (**EXHIBIT 51V**), CAUSE-PA (**EXHIBIT 51U**), and OSBA (**EXHIBIT 51W**), the Pennsylvania Public Utility Commission, largely has sidestepped and dismissed them, having ordered "that further concerns regarding the privacy of data accessible through a secure web portal can be adequately addressed in the *WPWG Proceeding*." (**EXHIBIT 51Y-1**.) The Commission subsequently stated in its **final order**: "the Electronic Data Exchange Working Group's *Pennsylvania Web Portal Working Group Technical Implementation Standards* are hereby **approved, as submitted**." (**EXHIBIT 51Y-4**.) (Emphasis added.)

65. A reading of the EDEWG's PA WPWG *Technical Implementation Standards* documents (**EXHIBITS 51X-1** and **51Y-3**) reveals significant potential for abuse of customers' data security and privacy.

EXHIBIT 46L-6 (FD):
Testimony of electrical engineer, William Bathgate, before Michigan House Energy Committee smart meter Bill 4220 hearing (Feb. 21, 2017). In this testimony excerpt, Mr. Bathgate discusses the remote programmability of wireless smart meters and the ease with which a meter's radio transmitters can be activated to transmit customer data entirely without the customer's knowledge. That such can occur and has occurred, whether inadvertently or not, further demonstrates one of a number of ways that customers' privacy is exceedingly vulnerable to abuse through the use of wireless smart meter technology.

EXHIBIT 52 (FD):
Fourth Amendment, Privacy and Power in a Digital World. L. K. Donahue, Georgetown University Law Center, 71 N.Y.U. Ann. Surv. Am. L. 533-685 (2017).http://scholarship.law.georgetown.edu/facpub/1791
Reads in part:

[Privacy and Power in a Digital World - Begin quote]

"[H]abitually to engage in such surveillance—without a warrant—is constitutionally intolerable."[188]
...
[O]nce technology enhanced the senses, then the risk altered. ..."There is no security from that kind of eavesdropping, no way of mitigating the risk, and so not even a residuum of true privacy."[271]
...
[B]ecause GPS data is detailed and digital, ... [i]t introduces a different form of knowledge acquisition ... ."[289]
...
In 2003, the state of Washington determined that, unlike binoculars or a flashlight, GPS systems did not merely enhance the natural senses.[294] They provided a substitute for visual tracking, resulting in significant intrusions into individuals' private affairs.[295] The text of the Washington state constitution mattered: "no person shall be disturbed in his private affairs, or his home invaded, without authority of law."[296] The Washington Supreme Court noted that the insight into individuals' private lives that can be gleaned by GPS data is substantial: ... Such information could provide details on citizens' preferences ... and predilections, drawing a "detailed picture of one's life."[298]
...
[T]he key question was whether the long-term monitoring ... violated the respondent's reasonable expectation of privacy.[319]
...

[L]onger-term monitoring impinges on expectations of privacy.[329]

...

"[U]nrestrained power to assemble data that reveal private aspects of identity," moreover, "is susceptible to abuse."[331] The privacy interests at stake were considerable. People [do] not "reasonably expect that their movements will be recorded and aggregated in a manner that enables the ... ascertain[ing], more or less at will, their ... habits ... ."[332] Such a tool, in the hands of the Executive and without any oversight, would be ripe for abuse.[333]

...

[T]he private/public distinction in Fourth Amendment doctrine ignores the possibility that the ***length of observation***, the ***recording of the information***, or the ***analysis of data*** obtained from the public domain could trigger a new privacy interests.

...

[T]he insight provided by such data into individuals' private lives is profound.

...

Regardless of who is watching, **ten weeks of surveillance implicates a range of privacy interests**. As more information can be obtained ... about the actions of individuals, incursions into the privacy sphere become deeper.

...

Relatedly, the most trenchant criticism of the private information/third-party data distinction revolves around the claim of ***voluntariness***. In the contemporary world, it is impossible to live one's daily life without entrusting a significant amount of information to third parties.[533] To say that we therefore *voluntarily* assume the risk that such information will be made public denies the role that technology plays. This phenomenon can be thought of as "digital dependence."

...

"Implicit in the concept of assumption of risk is some notion of **choice**."[573]... It made no sense to talk about "assuming the risk," as if it were a choice, when, in order to live in the contemporary world, one **in effect *had* no choice** ... .

Marshall's second objection was that risk analysis was an inappropriate tool. It allowed the government to set the contours of the Fourth Amendment. ... The question ought not to be what risks an individual presumably accepts by providing information to third parties, but what risks an individual "should be forced to assume in a free and open society."[576]

...

Individuals do have a clear privacy interest in a range of data entrusted to corporate entities. But even **where information may not appear to entail a privacy interest at the outset, when accumulated, much less when analyzed, possibly even in**

conjunction with other information, staggering insight into individuals' private lives may result.

...

... If all information entrusted to third parties loses its constitutional protections, then the right to privacy itself will gradually cease to exist.

...

"Neither individuals, institutions, nor government consistently demand or respect physical, informational, and proprietary privacy,"...[780]

188. United States v. Dunn, 480 U.S. 294 at 305 (1987) (Brennan, J., dissenting).
271. Lopez v. United States, 373 U.S. 427, 466 (1963) (Brennan, J., dissenting).
289. *See, e.g.*, State v. Jackson, 76 P.3d 217, 223 (Wash. 2003) ("We perceive a difference between the kind of **uninterrupted, 24-hour a day surveillance possible** through use of a GPS device ... and ... use of binoculars or a flashlight to augment ... senses.").
294. *Jackson*, 76 P.3d at 223.
295. *Id.*
296. WASH. CONST. art. 1, § 7, *construed in Jackson*, 76 P.3d at 222 ... .
298. Jackson, 76 P.3d at 223.
319. United States v. Jones, 132 S. Ct. 945 at 958 (2012) (Alito, J., concurring).
329. *Jones*, 132 S. Ct. at 955 (Sotomayor, J., concurring).
331. *Id.* at 956.
332. *Id.*
333. *Id.*
533. *See* Andrew William Bagley, *Don't Be Evil: The Fourth Amendment in the Age of Google, National Security, and Digital Papers and Effects*, 21 ALB. L. J. SCI. & TECH. 153, 154 (2011) (arguing that citizens are increasingly dependent on third party service providers for their daily lives and suggesting that companies, in turn, are becoming increasingly intermingled with government agencies); Brenner, *supra* note 78, at 52–59 (underscoring the danger of failing to recognize any privacy interest in the rapidly expanding amount of information entrusted to third parties).
573. Smith v. Maryland, 442 U.S. 735 at 749 (Marshall, J., dissenting) (citing his own dissent in California Bankers Assn. v. Shultz, 416 U.S. 21, 95–96 (1974)).
576. *Id*. at 750 (Marshall, J., dissenting).
780. Anita L. Allen, *Coercing Privacy*, 40 WM. & MARY L. REV. 723, 727–28 (1999).

[Privacy and Power in a Digital World - End quote] (Emphasis added.)

66. **ELECTRONIC SURVEILLANCE**
https://www.law.cornell.edu/wex/electronic_surveillance

"Electronic surveillance is defined in federal law as the **nonconsensual** acquisition by an electronic, mechanical, or other surveillance device of the contents of any wire or electronic communication, under circumstances in which a party to the communication has a reasonable expectation of privacy. The "contents" of a communication consists of any information concerning the identity of the parties, or the existence, substance, purport, or meaning of the communication."

...

"[T]he [Supreme] Court ... in Katz v. U.S. (1967) ... held that the Fourth Amendment protects any place where an individual maintains a reasonable expectation of privacy."

...

"[A] person has a legitimate expectation of privacy if he honestly and genuinely believes the location under surveillance is private, and if a reasonable person in the same or similar circumstances would believe the location to be private as well."

...

"Because electronic surveillance is a search under the Fourth Amendment, **it is subject to the same warrant requirements as other searches**." (Emphasis added.)

67. "Situations involving merely the transmission of electronic signals without trespass would *remain* subject to *Katz* analysis." *United States v. Jones*, 565 U.S. 400 at 412 (2012), 132 S.Ct. 945 (**EXHIBIT 50I**). See also *Florida v. Jardines*, 569 U.S. 1 (2013).

68. Under U.S. Code Title 50, Chapter 36, Subchapter I. ELECTRONIC SURVEILLANCE, Section **1801. Definitions** read in part (underlining and emphasis added):

(f) "Electronic surveillance" means—

...

(3) the intentional acquisition by an electronic, mechanical, or other surveillance device of the contents of **any** radio communication, **under circumstances in which a person has a reasonable expectation of privacy and a warrant would be required for law enforcement purposes**, and if both the sender and all intended recipients are located within the United States;

(4) the **installation or use of an electronic**, mechanical, or other surveillance **device** in the United States **for monitoring to acquire information**, other than from a wire or radio communication, **under circumstances in which a person has a reasonable expectation of privacy and a warrant would be required for law enforcement purposes**.

...

(k) "Aggrieved person" means a person who is the target of an electronic surveillance or any other person whose communications **or activities** were subject to electronic surveillance.

...

(m) "Person" means **any individual**, including any officer or employee of the Federal Government, or any group, entity, association, corporation, or foreign power.

(n) "Contents", when used with respect to a communication, includes any information concerning the identity of the parties to such communication or the existence, substance, purport, or meaning of that communication.

Section 1809. Criminal Sanctions

(a) Prohibited activities A person is guilty of an offense if he intentionally—

(1) engages in electronic surveillance under color of law except as authorized by this chapter, chapter 119, 121, or 206 of title 18, or any express statutory authorization that is an additional exclusive means for conducting electronic surveillance under section 1812 of this title;

(2) discloses or uses information obtained under color of law by electronic surveillance, knowing or having reason to know that the information was obtained through electronic surveillance not authorized by this chapter, chapter 119, 121, or 206 of title 18, or any express statutory authorization that is an additional exclusive means for conducting electronic surveillance under section 1812 of this title.

Section 1810. Civil Liability

An aggrieved person, other than a foreign power or an agent of a foreign power, as defined in section 1801(a) or (b)(1)(A) of this title, respectively, who has been subjected to an electronic surveillance or about whom information obtained by electronic surveillance of such person has been disclosed or used in violation of section 1809 of this title shall have a cause of action against any person who committed such violation and shall be entitled to recover—

(a) actual damages, but not less than liquidated damages of $1,000 or $100 per day for each day of violation, whichever is greater;

(b) punitive damages; and

(c) reasonable attorney's fees and other investigation and litigation costs reasonably incurred.

Section 1812. Statement of exclusive means by which electronic surveillance and interception of certain communications may be conducted

(a) Except as provided in subsection (b), the procedures of chapters 119, 121, and 206 of title 18 and this chapter shall be the exclusive means by which electronic

surveillance and the interception of domestic wire, oral, or electronic communications may be conducted.

(b) Only an express statutory authorization for electronic surveillance or the interception of domestic wire, oral, or electronic communications, other than as an amendment to this chapter or chapters 119, 121, or 206 of title 18 shall constitute an additional exclusive means for the purpose of subsection (a).

If, pursuant to Act 129 and acting under color of law as a state actor or agent of an agency of the State, PPL proceeds—by means of threatening to terminate our access to vital electric service—to coerce our consent to the installation on our home of an AMI wireless smart meter device, PPL's subsequent use of that device, in perpetually collecting and transmitting from our home more data with content of a personal and private nature than is minimally necessary for generating a monthly bill, shall be ***without our consent*** and shall constitute **electronic surveillance** as defined and expounded under 50 U.S.C. 36, Subchapter I, §§ 1801(f), 1809(a), 1810, and 1812.

If, pursuant to Act 129 and acting under color of law as a state actor or agent of an agency of the State, PPL proceeds—by means of threatening to terminate our access to vital electric service—to coerce our consent to the installation on our home of an AMI wireless smart meter device, PPL's subsequent use of that device, in perpetually collecting and transmitting from our home more data with content of a personal and private nature than is customary and minimally necessary for generating a monthly bill, shall be ***without our consent*** and shall constitute a deprivation of our Fourth Amendment right to reasonable expectation of privacy.

D. Prevailing Legislative Intent

This section includes the following:

Exhibit Nos. 47A, 47B, 47C, 47D, 47E, 47F, and 48.

All of the exhibits listed within this section constitute directly relevant and highly credible evidence of absolutely and completely reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

Explication and justification of the evidentiary exhibits in this section is given full relevance within the context of matters of law and the Complainants' assertions of fact.

1. The exact language pertinent to this matter under **66 PA.C.S. § 2807(f)(2)** and enacted in to law as part of **Act 129** is as follows:

(2) Electric distribution companies shall furnish smart meter technology as follows:

(i) Upon request from a customer that agrees to pay the cost of the smart meter at the time of the request.

(ii) In new building construction.

(iii) In accordance with a depreciation schedule not to exceed 15 years.

(Underlining added.)

2. In the Pennsylvania Public Utility Commission Hearing, dated January 24, 2013 and pertaining to *Maria Povacz v. PECO Energy Company* (C-2012-2317176) (**EXHIBIT 47A, FD**), the following several statements were put forth as rationale and justification of the Commission's 'no opt-out' policy:

"The ALJ stated that the use of the word 'shall' in the statute indicates the General Assembly's direction that all customers will receive a smart meter. ... Furthermore, noted the ALJ, there is no provision in the statute that allows customers to 'opt out' of smart meter installation ... ." (p. 6.)

"The ALJ continued that neither the Commission's Orders implementing this provision of Act 129, nor PECO's specific implementation plan, allow customers to 'opt out' of smart meter installation." (p. 7.)

"PECO relies, in part, on the following language from the Commission's *Smart Meter Implementation Order, supra,* to support its argument that the Complainant cannot opt out of the smart meter installation:

The Commission believes that it was the intent of the General Assembly to require all covered [Electric Distribution Companies] 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.' ... 'the Commission's Order does not have a provision for customers to "opt out" of the smart meter installation.'" (p. 7.)

"Additionally, as noted by the ALJ, Section 2807(f)(2) of the Code, *supra*, is controlling here, and the use of the word 'shall' in the statute indicates the General Assembly's direction that all customers will receive a smart meter." (p. 10.)

3. The law, as stated, directs electric utility companies (EDCs) simply to furnish—that is, to offer, provide, or make available—smart meter technology under the conditions specified by provisions (i), (ii) and (iii) above.

4. Provision (i) requires EDCs to furnish—to offer, provide, or make available—smart meter technology to customers who request such and who agree to pay the cost of the smart meters at the time of their requests.

5. Provision (iii) requires EDCs to furnish—to offer, provide, or make available—smart meter technology in accordance with a maximum 15-year schedule of depreciation.

6. Act 129 contains no explicit language which states that EDCs must install AMI smart meters on homes or properties of customers who do not want or do not consent to them.

7. Act 129 contains no non-vague language which clearly and unambiguously implies or would imply that EDCs must install AMI smart meters on homes or properties of customers who do not want or do not consent to them.

8. Act 129 contains no explicit language which states that customers cannot opt out of having AMI smart meters installed.

9. Act 129 contains no non-vague language which clearly and unambiguously implies or would imply that customers cannot opt out of having AMI smart meters installed.

10. There is no provision in the statute, Act 129, that explicitly disallows customers from 'opting out' of smart meter installation.

11. There is no non-vague provision in the statute, Act 129, which clearly and unambiguously disallows or would disallow customers from 'opting out' of smart meter installation.

12. The absence of explicit *opt-out* language in Act 129 does not logically entail, and is not necessarily equivalent or tantamount to, an automatic, universal opt-in.

13. The language expressed by provision (i) of § 2807(f)(2) is explicitly *opt-in* language, making the choice of having a smart meter installed optional on the part of the customer.

14. The interpretation of § 2807(f)(2) by the Pennsylvania Public Utility Commission is such that, explicitly on the one hand, customers can request a smart meter, that is, they can opt in or could have opted in, but implicitly on the other hand, they cannot opt out and could not have opted out.

15. Not only is this interpretation by the Commission inconsistent, it renders provision (i) of § 2807(f)(2) as being virtually superfluous and practically moot, effectively preempting the legislative intent of the General Assembly as expressed in that provision. Even if customers had requested and agreed to pay for the installation of smart meters, they would not have been able to realize any advantage of doing so until their EDCs had implemented their Smart Meter Plans to make the requisite smart meter technology and system infrastructure available and fully functional.

16. As evidenced by assertion of fact no. 2, supra, the Commission's 'no opt-out' policy pursuant to § 2807(f)(2) is predicated entirely upon the word "shall" and upon the provision (iii) phrase: "in accordance with a depreciation schedule not to exceed 15 years." (**EXHIBIT 47A**.)

17. Provision (iii) of § 2807(f)(2) simply establishes a specified schedule, or limiting time frame.

18. The fact that the type of schedule specified by provision (iii) is a depreciation schedule can be interpreted as having three possible meanings:

(1) EDCs would have a maximum period of 15 years to claim depreciation on their existing equipment while in the process of upgrading their facilities and infrastructure so as to be capable of offering or providing smart meter technology to their customers.

(2) It is the AMI smart meter facilities and equipment, which, as the technology is implemented and made available to customers by their EDCs, are permitted to be depreciated over a period not greater than 15 years.

(3) The depreciation schedule applies to both existing facilities and the phasing in of the new smart meter technology.

19. **Paragraph (7) of 66 PA.C.S. § 2807(f)** reads in part: "An electric distribution company may recover reasonable and prudent costs of ***providing*** smart meter technology under paragraph (2)(ii) and (iii), as determined by the commission. This paragraph includes annual ***depreciation*** and capital costs over the life ***of the smart meter technology*** and the cost of any system upgrades that the electric distribution company may require to enable the use of the smart meter technology which are incurred after the effective date of this paragraph, less operating and capital cost savings realized by the electric distribution company from the installation and use of the smart meter technology." (Underlining, emphasis and italics added.)

20. In PPL Electric Utilities' *AMI Program Communications Plan*, dated January 15, 2016, it is stated that "charges [for the new meters] will continue through the expected 15-year lifespan of the meters." (p. 23.) (**EXHIBIT 48, FD.**)

21. Assertions of fact nos. 18, 19 and 20, supra, indicate that the 15-year depreciation schedule set forth by provision (iii) of § 2807(f)(2) is intended to apply to the ***new*** AMI smart meter technology. That is, the interpretation expressed by statement (2) of assertion no. 18 is the correct interpretation of provision (iii) of § 2807(f)(2).

22. Assertions of fact nos. 17 through 21, supra, provide confirmation that provision (iii) of § 2807(f)(2) almost certainly has everything to do with placing a time limit on depreciation of ***new*** equipment, that is, of smart meter technology, as allowed under paragraph (7) of § 2807(f), and nothing to do with establishing a mandate requiring system-wide implementation of AMI smart meter technology *with no customer opt-out*.

23. There is no non-vague language, explicit or implicit, clearly and unambiguously expressed in provision (iii) alone, or in combination with any other part of § 2807(f)(2), which definitively would establish the Commission's 'no opt-out' interpretation of that paragraph under Act 129 as a mandate expressing the legislative intent of the General Assembly.

24. **EXHIBIT 47B (FD)**, a copy of House Bill HB 2200, Printer's No. 4429 (Sept. 23, 2008), includes the following stricken language:

~~Section 4. Section 2807(e) of Title 66 is amended by adding a paragraph to read:~~

~~§ 2807. Duties of electric distribution companies~~.

...

~~(ii) Electric distribution companies shall furnish smart meter technology to:~~

~~(A) Customers responsible for 40% of the distribution company's annual peak demand within four years after the effective date of this paragraph.~~

~~(B) Customers responsible for 75% of the distribution company's annual peak demand within six years after the effective date of this paragraph.~~

~~(C) One hundred percent of its customers within~~

~~ten years after the effective date of this paragraph.~~

In the same Printer's No. 4429 document, the above language was changed to:

SECTION 3. SECTION 2807(E) OF TITLE 66 IS AMENDED AND THE SECTION IS AMENDED BY ADDING SUBSECTIONS TO READ:
§ 2807. DUTIES OF ELECTRIC DISTRIBUTION COMPANIES.
...

(2) ELECTRIC DISTRIBUTION COMPANIES SHALL FURNISH SMART METER TECHNOLOGY AS FOLLOWS:

(I) UPON REQUEST TO A CUSTOMER THAT AGREES TO PAY THE COST OF THE SMART METER.

(II) IN THE CONSTRUCTION OF A NEW RESIDENCE OR NEW BUILDING TO BE USED BY A COMMERCIAL CUSTOMER.

(III) IN ACCORDANCE WITH A SCHEDULE OF REPLACEMENT OF FULL DEPRECIATION OF EXISTING METERS.

The language of § 2807 thus had been changed at this point ***from*** the stricken

"(ii) Electric distribution companies shall furnish smart meter technology to: ... (C) One hundred percent of its customers within ten years after the effective date of this paragraph"

to

"(2) ELECTRIC DISTRIBUTION COMPANIES SHALL FURNISH SMART METER TECHNOLOGY AS FOLLOWS: ... (III) IN ACCORDANCE WITH A SCHEDULE OF REPLACEMENT OF FULL DEPRECIATION OF **EXISTING** METERS." (Underlining and emphasis added.)

Immediately prior to the enactment HB 2200 into law as Act 129, provision (III) in the language of the foregoing version was changed to "(III) IN ACCORDANCE WITH A DEPRECIATION SCHEDULE NOT TO EXCEED 15 YEARS" as per **EXHIBIT 47C** referenced in assertion of fact no. 25, *infra*.

The phraseology of the earlier provision, "shall furnish smart meter technology to ... One hundred percent of its customers within ten years," may have implied a system-wide mandate. However, by amendment, ***this provision was stricken*** and replaced simply with a provision which at first allowed for depreciation of ***existing***

meters over an indefinite period. Then, with one final modification of the latter provision, a definite time limit of 15 years was set for depreciation which could be interpreted as being applicable to both existing meters and new AMI smart meters. Again, provision (iii) most clearly has everything to do with allowing for equipment depreciation and nothing to do with establishing a mandate requiring system-wide implementation of AMI smart meter technology with no customer opt-out.

25. **EXHIBIT 47C (FD)**, a copy of House Bill HB 2200, Printer's No. 4526 (Oct. 7, 2008), includes the following language as further changed from that in Printer's No. 4429:

SECTION 3. SECTION 2807(E) OF TITLE 66 IS AMENDED AND THE SECTION IS AMENDED BY ADDING SUBSECTIONS TO READ:

§ 2807. DUTIES OF ELECTRIC DISTRIBUTION COMPANIES.
...

(2) ELECTRIC DISTRIBUTION COMPANIES SHALL FURNISH SMART METER TECHNOLOGY AS FOLLOWS:

(I) UPON REQUEST FROM A CUSTOMER THAT AGREES TO PAY THE COST OF THE SMART METER AT THE TIME OF THE REQUEST.

(II) IN NEW BUILDING CONSTRUCTION.

(III) IN ACCORDANCE WITH A DEPRECIATION SCHEDULE NOT TO EXCEED 15 YEARS.

This is the language of the *final version* of § 2807 of HB 2200 *as amended by the Pennsylvania Senate*. It is this version of § 2807 which is expressed in the exact language as that under § 2807(f)(2) of Title 66 of the Public Utility Code and which was enacted into law under Act 129. (**EXHIBIT 47D, FD**.)

26. In the ***Legislative Journal of the Pennsylvania Senate,*** dated October 8, 2008, (**EXHIBIT 47E, FD**), at least three Pennsylvania senators representing both major political parties are on public record as having stated ***explicitly*** that **smart meters were not mandated**. Consistent with the sequence in the series of changes made to the language of § 2807, as previously shown in assertions of fact nos. 24 and 25, supra, and ***consistent with the explicit statements made by these senators*** *concerning the Senate's final amendments to HB 2200*, ***smart meters were not and would not be mandatory, but were made optional*** to ratepayers. Specifically:

"It also contains language in there that we will have smart meters. **It is not mandated**, but it allows for the deployment of smart meters through a depreciation process, through new home construction process, and through the depreciation of 15 years, and for anyone who wants to purchase a smart meter which they feel will help them manage their electric load better."

—Senator Tomlinson (Senate Legislative Journal, p. 2626.)
(Underlining and emphasis added.)

"We also made sure that **smart meters would not be mandated** for every single ratepayer. Not only is that a smarter approach to smart meter deployment, but it will also save electric customers hundreds of millions of dollars paying for something that will not provide a real benefit in their own households."

—Senator Boscola (Senate Legislative Journal, p. 2627.)
(Underlining and emphasis added.)

"In addition, **we did not mandate smart meters**, but **we made them optional**. We did say in new construction, where they really are practical, they will be put in."

— Senator Fumo (Senate Legislative Journal, p. 2629.)
(Underlining and emphasis added.)

As thus amended by the Pennsylvania Senate on the matter concerning smart meters, the final version of HB 2200, ***with the amendments making smart meters non-mandatory***, was passed by the Senate by an overwhelming majority of **47 to 3**. (Legislative Journal - Senate, October 8, 2008, p. 2631. (**EXHIBIT 47E**, **FD.**) The bill was then returned to the Pennsylvania House for a final vote.

To the Speaker of the House's question: "**Will the House concur in Senate amendments?**", HB 2200 as amended by the Pennsylvania Senate was passed by the Pennsylvania House of Representatives by an overwhelming majority of **186 to 4** such that "...**the question was determined in the affirmative and the amendments were concurred in**." (***Legislative Journal of the Pennsylvania House of Representatives,*** dated October 8, 2008, p. 2327. (**EXHIBIT 47F, FD**.) (Underlining and emphasis added.)

HB 2200 was thus enacted by the Pennsylvania General Assembly and signed into law as Act 129 by then-Governor Rendell.

27. It is clear the ***prevailing*** **legislative intent** enacted into law as Act 129 expresses the Pennsylvania General Assembly's direction that **smart meters were not made and would not be made mandatory**.

28. The Pennsylvania Public Utility Commission has jurisdiction over the state's public electric utilities.

29. The Commission does not have statutory authority or jurisdiction over the public.

30. The Commission has authority to mandate that the state's electric utilities *offer* wireless smart meters for use by the public, but the Commission cannot mandate or require that the utilities install smart meters on the private properties of persons who do not want or do not consent to them.

E. State Action Doctrine

This section includes the following:

Exhibit Nos. 50A, 50B, 50C, 50D, 50E, 50F, 50G, and *Letter 2* (from Respondent's representative to the Complainants).

All of the exhibits listed within this section constitute directly relevant and highly credible evidence of absolutely and completely reasonable probative value in accordance with item *III, Evidentiary Standards and Criteria*, supra.

Explication and justification of the evidentiary exhibits in this section is given full relevance within the context of matters of law and the Complainants' assertions of fact.

Respondent PPL Electric Utilities cites *Jackson v. Metropolitan Edison Co*., 419 U.S. 345 (1974), in an attempt to support its claim that PPL is not a 'state actor' in the instant case and to absolve itself of liability for its unlawful actions.

In *Jackson*, "a customer sued a privately owned utility under the Civil Rights Act of 1871 for improperly shutting off her service without providing her notice or a hearing. The Supreme Court asked whether there was a close enough nexus between the state and the utility for the acts of the latter to be treated as those of the former. Although the utility was heavily regulated by the state, it was held not to be a state actor. The Court reasoned that the provision of utility service is not generally an 'exclusive prerogative of the State.' Also absent was the symbiotic relationship between the utility and the state found in previous cases." (Congressional Research Service, CRS Report for Congress, Document R42338, February 3, 2012.)

"Though its holding [in *Jackson*] was broad **the Court did not foreclose the possibility that a privately owned utility could be a state actor under different circumstances**." (CRS Report for Congress, Document R42338, supra.) (Emphasis added.)

"Faithful adherence to the 'state action' requirement of the Fourteenth Amendment requires careful attention to the gravamen of the plaintiff's complaint." *Blum v. Yaretsky*, 457 U.S. 991, 1003 (1982). **(EXHIBIT 50A.)**

"[T]he inquiry must be whether there is a sufficiently close nexus between the State and the challenged action of the regulated entity so that the action of the latter may be fairly treated as that of the State itself." *Jackson v. Metropolitan Edison Co.*, 419 U.S. 345, 351. **(EXHIBIT 50B.)**

"Our cases have accordingly insisted that the conduct allegedly causing the deprivation of a federal right be fairly attributable to the State. These cases reflect a two-part approach to this question of 'fair attribution.' First, the deprivation must be caused by the exercise of some right or privilege created by the State or by a rule of conduct imposed by the State or by a person for whom the State is responsible. ... Second, the party charged with the deprivation must be a person who may fairly be said to be a state actor. This may be because he is a state official, because he has acted together with or has obtained significant aid from state officials, or because his conduct is otherwise chargeable to the State." *Lugar v. Edmondson Oil*, 457 U.S. 922 (1982). **(EXHIBIT 50C.)**

In *Lugar v. Edmondson Oil*, 457 U.S. 922, 942 (1982), the Court stated:

"[W]e have consistently held that a private party's joint participation with state officials in the seizure of disputed property is sufficient to characterize that party as a 'state actor' for purposes of the Fourteenth Amendment. The rule in these cases is the same as that articulated in *Adickes v. S. H. Kress & Co.*, supra, at 152, in the context of an equal protection deprivation:

'"Private persons, jointly engaged with state officials in the prohibited action, are acting "under color" of law for purposes of the statute. To act "under color" of law does not require that the accused be an officer of the State. It is enough that he is a willful participant in joint activity with the State or its agents,"' quoting *United States v. Price*, 383 U.S., at 794."

"[I]f the government coerces, influences, or encourages the performance of the act, it is state action." https://en.wikipedia.org/wiki/State_actor (See e.g., *Rendell-Baker v. Kohn*, 457 U.S. 830 (1982).)

"Relying on Flagg Brothers, Inc. v. Brooks, 436 U.S. 149 (1978); Jackson v. Metropolitan Edison Co., 419 U.S. 345 (1974); Moose Lodge No. 107 v. Irvis, 407 U.S. 163 (1972); and Adickes v. S. H. Kress Co., 398 U.S. 144 (1970), the Court held that, 'a State normally can be held responsible for a private decision only when it has exercised coercive power or has provided such significant encouragement, either overt or covert, that the choice must in law be deemed to be that of the State.'" Rendell-Baker v. Kohn, 457 U.S. 830, 839 (1982). **(EXHIBIT 50D.)**

A state can be held liable for exercising coercive power or significantly encouraging, either overtly or covertly, a private party. *Blum v. Yaretsky,* 457 U.S. 991 at 1002-03 (1982).

"Not even the fact that the actions of the state agents are illegal under state law makes the action unattributable to the state for purposes of the Fourteenth Amendment."
https://www.law.cornell.edu/constitution-conan/amendment-14/section-1/state-action#fn1344amd14

"Misuse of power, possessed by virtue of state law and made possible only because the wrongdoer is clothed with the authority of state law, is action taken 'under color of' state law." *United States v. Classic*, 313 U.S. 299, 326 (1941).

"Actions of the state that are considered in any analysis should include passive as well as active state involvement. The essential ingredient in this respect is knowledge. If the state is cognizant of the challenged activity and chooses not to prevent it, then for all purposes encouragement of the activity is taking place." *The State Action Doctrine in State and Federal Courts*, Hala Ayoub, Florida State University Law Review, Vol. 11, 1984.

In a letter, dated January 16, 2018, and addressed to us, Sheila Ketterer, PPL Director of Advanced Metering & Data Operations, responding directly on behalf of Gregory Dudkin, President and Director of PPL Electric Utilities Corporation, stated: "**Pennsylvania Act 129**, passed into law in 2008, **requires electric utilities** with more than 100,000 customers **to provide those customers with advanced meters** that have specific capabilities. **PPL Electric Utilities ... is subject to this requirement. The specific language, found in Section 3 of the law, says utilities 'shall furnish' these meters. Act 129 does not include language allowing either customers or utilities to opt out of advanced meter installation.** As a result, we cannot honor customers' requests not to replace their meters." **(Letter 2, (FD).)** (Emphasis added.)

Ms. Ketterer, on behalf of Mr. Dudkin, thus has asserted that the actions of PPL in this matter are, and have been, **compelled** by the State.

As has been shown under Section IV-D, "*Prevailing* Legislative Intent," supra, it is *not* the enactment of Pennsylvania's Act 129 by the state legislature which is responsible for mandating state-wide installation of wireless smart meters. Rather, it is the Pennsylvania Public Utility Commission which bears that responsibility with its no-opt-out implementation policy based entirely on its misconstruction of the explicitly-expressed legislative intent of the Pennsylvania General Assembly. (That explicitly-expressed legislative intent, which is on public record, was that smart meters were not mandated and would not be mandated.) By this means, the Commission has directly insinuated its own interests and intent into the actions of PPL and the state's other electric utilities with regard to the mandatory installation of wireless smart meter devices and technology, which never have been studied or tested specifically for biological or health effects and which the Commission and the electric utilities have forced upon customers and the public at large without their informed consent.

By virtue of its actions directly pursuant to the Pennsylvania Public Utility Commission policy and implementation **order mandating system-wide** installation of smart meters, PPL Electric Utilities' "conduct has sufficiently received the imprimatur of the State so as to make it 'state' action for purposes of the Fourteenth Amendment." *Blum v. Yaretsky*, supra. See also *Flagg Bros., Inc. v. Brooks*, 436 U.S. 149 (1978); *Jackson v. Metropolitan Edison Co.*, supra; *Moose Lodge No. 107 v. Irvis*, 407 U.S. 163 (1972); *Adickes v. S. H. Kress & Co.*, 398 U.S. 144 (1970).

In a dissenting opinion on the divergence of the Court's analysis of 'state action' in *Jackson v. Metropolitan Edison* from that in *Burton v. Wilmington Parking Authority*, 365 U.S. 715, (1961) **(EXHIBIT 50E)**, Justice Douglas wrote:

[Justice Douglas dissent - Begin quote]

... May a utility have complete immunity under federal law when the State allows its regulatory agency to become the prisoner of the utility or, by a listless attitude of no concern, to permit the utility to use its monopoly power in a lawless way?

...

In Burton v. Wilmington Parking Authority, 365 U.S. 715 (1961), we said: "Only by sifting facts and weighing circumstances can the nonobvious involvement of the State in private conduct be attributed its true significance." Id., at 722. A particularized inquiry into the circumstances of each case is necessary in order to determine whether a given factual situation falls within "the variety of individual-state relationships which the [Fourteenth] Amendment was designed to embrace."

Ibid. As our subsequent discussion in Burton made clear, the dispositive question in any state-action case is not whether any single fact or relationship presents a sufficient degree of state involvement, but rather whether the aggregate of all relevant factors compels a finding of state responsibility. 2 Id., at 722-726. See generally Moose Lodge No. 107 v. Irvis, 407 U.S. 163 (1972).

...

It is not enough to examine seriatim each of the factors upon which a claimant relies and to dismiss each individually as being insufficient to support a finding of state action. It is the aggregate that is controlling.

...

... In the present case, however, respondent is not just one person among many; it is the only public utility furnishing electric power to the city. When power is denied a householder, the home, under modern conditions, is likely to become unlivable.

Respondent's procedures for termination of service may never have been subjected to the same degree of state scrutiny and approval, whether explicit or implicit, that was present in Public Utilities Comm'n v. Pollak, 343 U.S. 451 (1952). Yet in the present case the State is heavily involved in respondent's termination procedures, getting into the approved tariff a requirement of "reasonable notice." Pennsylvania has undertaken to regulate numerous aspects of respondent's operations in some detail, 5 and a "hands-off" attitude of permissiveness or neutrality toward the operations in this case is at war with the state agency's functions of supervision over respondent's conduct in the area of servicing householders, particularly where (as here) the State would presumably lend its weight and authority to facilitate the enforcement of respondent's published procedures. Cf. Adickes v. S. H. Kress & Co., 398 U.S. 144 (1970); Reitman v. Mulkey, 387 U.S. 369 (1967); Railway Employes' Dept. v. Hanson, 351 U.S. 225 (1956); Shelley v. Kraemer, 334 U.S. 1 (1948).

In the aggregate, these factors depict a monopolist providing essential public services as a licensee of the State and within a framework of extensive state supervision and control. The particular regulations at issue, promulgated by the monopolist, were authorized by state law and were made enforceable by the weight and authority of the State. Moreover, the State retains the power of oversight to review and amend the regulations if the public interest so requires. Respondent's actions are sufficiently intertwined with those of the State, and its termination-of-service provisions are sufficiently buttressed by state law to warrant a holding that respondent's actions in terminating this householder's service were "state action" for the purpose of giving federal jurisdiction over respondent under 42 U.S.C. 1983. ...

...

Section 1983 was designed to give citizens a federal forum 6 for civil rights complaints wherever, by direct or indirect actions, a State, acting "in cahoots" with

a private group or through neglect or listless oversight, allows a private group to perpetrate an injury. The theory is that in those cozy situations, local politics and the pressure of economic overlords on subservient state agencies make recovery in state courts unlikely. ...

Section 1983 addresses itself to grievances inflicted "under color of any statute, ordinance, [or] regulation . . . of any State . . . ." The regulatory regime imposed by Pennsylvania on respondent utility seems to fit this statute like a glove. Electrical service, being a necessity of life under the circumstances of this case, is an entitlement which under our decisions may not be taken without the requirements of procedural due process. Fuentes v. Shevin, 407 U.S. 67, 80 (1972); Goldberg v. Kelly, 397 U.S. 254 (1970); Palmer v. Columbia Gas of Ohio, Inc., 479 F.2d 153 (CA6 1973).

...

2 The court below in Burton had relied heavily on a number of facts indicating minimal state involvement, but we regarded that court's analysis as unduly restricted in its scope: "While these factual considerations are indeed validly accountable aspects of the enterprise upon which the State has embarked, we cannot say that they lead inescapably to the conclusion that state action is not present. Their persuasiveness is diminished when evaluated in the context of other factors which must be acknowledged." 365 U.S., at 723. After discussing those additional factors in greater detail, we concluded: "Addition of all these activities, obligations and responsibilities of the Authority, the benefits mutually conferred, together with the obvious fact that the restaurant is operated as an integral part of a public building devoted to a public parking service, indicates that degree of state participation and involvement in discriminatory action which it was the design of the Fourteenth Amendment to condemn." Id., at 724.

...

5 The Public Utility Commission is given extensive control over utility rates, Pa. Stat. Ann., Tit. 66, 1141 et seq. (1959 and Supp. 1974-1975), and over the character and quality of utility services and facilities, 1171, 1182-1183; it is given broad power to receive and investigate complaints, 1391, 1398, and to regulate and supervise the activities, rules, and contractual undertakings of utilities, 1171, 1341-1343, 1360.

6 There is no requirement for an exhaustion of state remedies before suing under 1983 (see Wilwording v. Swenson, 404 U.S. 249 (1971)), though suggestions for statutory changes in that regard have been made. Judd, The Expanding Jurisdiction of the Federal Courts, 60 A. B. A. J. 938, 941 (1974)."

[Justice Douglas dissent - End quote] (Jackson v. Metropolitan Edison Co., 419 U.S. 345 (1974).)

In *Braden v. University of Pittsburgh*, 552 F.2d 948, 956-58 (1977) **(EXHIBIT 50F)**, the U.S. Court of Appeals for the Third Circuit held:

[Third Circuit opinion - Begin quote]

II. STATE ACTION.

... It is incumbent upon this Court to determine which, if either, of these cases Burton or Jackson may control the present situation and, in so doing, whether Jackson has superseded Burton as the preeminent declaration on state action with respect to circumstances such as we have here.

In Burton, the Court held that a private restaurant owner who refused service to a customer because of his race, violated the Fourteenth Amendment where the restaurant was located in a building owned by a state-created parking authority and leased from that authority. After a thorough review of the relationship between the restaurant and the authority, the Supreme Court concluded that the state had "so far insinuated itself into a position of interdependence with (the restaurant) that it must be recognized as a joint participant in the challenged activity, which, on that account, cannot be considered to have been so 'purely private' as to fall without the scope of the Fourteenth Amendment."[40] It is thus apparent that the dispositive factor in Burton, with respect to the state action issue, was the extent and nature of the overall relationship between the state agency and the private enterprise.

Decided thirteen years after Burton, Jackson concerned a different type of nongovernmental entity, namely, a privately owned and operated utility corporation. The utility was, however, subject to extensive state regulation in many particulars of its business. When the utility company terminated the electric service of a customer without notice, without a hearing, or without an opportunity to pay any amounts due, the customer charged that she had been denied due process. The Supreme Court rejected the due process claim on the ground that, since state action was not present, the utility was exempt from constitutional commands. It held that the Commonwealth of Pennsylvania was not sufficiently connected with the challenged termination to make the conduct of the private utility corporation attributable to the state for purposes of the Fourteenth Amendment.

Important to the inquiry here is the analytical formula set forth in Jackson respecting state action. For the Supreme Court stated there that, when considering the vexing state action issue, the "inquiry must be whether there is a sufficiently close nexus between the state and the challenged action of the regulated entity so that the action of the latter may be fairly treated as that of the State itself."[41]

Appellants maintain that this "close nexus" test, rather than the "relationship" approach of Burton, should be applied in the case at bar. They contend that, for state action to exist, the Commonwealth must be closely involved with the challenged employment practices of the University. In so arguing, appellants imply that the vitality of Burton has been severely undermined by Jackson, and that the existence of a pervasive relationship between the Commonwealth and the University is not, standing alone, sufficient to undergird a ruling of state action.[42] While Jackson may invite some concern as to the present status of Burton, we do not find appellants' reading of these cases to be convincing. To the contrary, in our view, Burton retains viability, and so its teachings may well bear on the present inquiry.

Based on a review of the Supreme Court's opinion in Jackson, we believe that that decision would not preclude application of the precepts of Burton here, should the appropriate state-private relationship exist. Instead of overruling Burton, the Jackson Court merely distinguished the earlier opinion, finding "absent in (Jackson) the symbiotic relationship presented in Burton . . . ."[43] The implication arising from such efforts at differentiation is not that Burton was supplanted by Jackson, but rather that Burton remained as a powerful precedent with which the Court had to contend. Moreover, the Jackson opinion repeatedly cites Burton with apparent approval,[44] hardly sounding the death knell for Burton that the appellants would have us perceive.

It may be that only in the absence of an inextricably-linked relationship between the state and a private entity does the "close nexus" test of Jackson come into play. Where a private enterprise stands, in its operations, as a veritable partner with the state, then it seems proper to hold such enterprise subject to the same constitutional requirements to which the state is accountable. ... [A]s we understand it, Burton and Jackson stand as two models of state-action analysis that have been designed by the Supreme Court to date, with the applicability of either approach resting on the type of setting which may be present.[46]

... Indeed, the Supreme Court declared in Burton that "only by sifting facts and weighing circumstances . . ." can matters turning on state action be resolved.[47] And such emphasis on the factual elements was echoed in Jackson as well.[48]

...

Not only does it appear that the state in this situation, as in Burton, has "insinuated itself into a position of interdependence" with Pitt, but it seems to be a "joint participant" ... as well.

...

It should be observed that Jackson was decided immediately after the opinion in Isaacs was rendered. Since Isaacs so heavily relies, quite properly, on Burton, the analysis presented by Judge Higginbotham remains valid only so long as Jackson is

not construed to overrule or devitalize Burton. As we fail to so read Jackson, the principles espoused in Isaacs remain supportive of the conclusion reached by the trial judge that state action cannot be ruled out summarily in the case at bar.

...

Having concluded that Burton retains vitality, we must examine the available materials concerning the nature and extent of the connection ... . Indeed, the Supreme Court declared in Burton that "only by sifting facts and weighing circumstances . . ." can matters turning on state action be resolved.[47] And such emphasis on the factual elements was echoed in Jackson as well.[48]

...

40 365 U.S. at 725, 81 S. Ct. at 862
41 419 U.S. at 351, 95 S. Ct. at 453
42 See Brief for Appellants at 20-25
43 419 U.S. at 357, 95 S. Ct. at 457
44 See, e. g., id. at 350, 351, 95 S. Ct. 449

This Court has, on a number of previous occasions, indicated that Burton is very much a viable precedent. See, e. g., Broderick v. Associated Hospital Service of Philadelphia, 536 F.2d 1, 4 (3d Cir. 1976); Magill v. Avonworth Baseball Conference, 516 F.2d 1328, 1332 (3d Cir. 1975).

46 Moose Lodge No. 107 v. Irvis, 407 U.S. 163, 92 S. Ct. 1965, 32 L. Ed. 2d 627 (1972), though decided before Jackson, indicates that a bipartite approach to state action is the proper one. In declining to find state action in Moose Lodge, the Court seemingly invoked both the "close nexus" and "overall relationship" formulas:

However detailed this type of (private club) regulation may be in some particulars, it cannot be said to in any way foster or encourage (the) discrimination. Nor can it be said to make the State in any realistic sense a partner or even a joint venturer in the club's enterprise."

Id. at 176-77, 92 S. Ct. at 1973.

The Supreme Court has, of course, fashioned other analytical frameworks to deal with state action problems of a different complexion. See, e. g., Hudgens v. N.L.R.B., 424 U.S. 507, 96 S. Ct. 1029, 47 L. Ed. 2d 196 (1976); Evans v. Newton, 382 U.S. 296, 86 S. Ct. 486, 15 L. Ed. 2d 373 (1966); Marsh v. Alabama, 326 U.S. 501, 66 S. Ct. 276, 90 L. Ed. 265 (1946).

47 365 U.S. at 722, 81 S. Ct. at 860
48 419 U.S. at 351, 95 S. Ct. 449

[Third Circuit opinion - End quote]

"Utility service is a necessity of modern life; indeed, the discontinuance of water or heating for even short periods of time may threaten health and safety." (Memphis Light, Gas & Water Div. v. Craft, 436 U.S. 1 (1978).)

In its analysis following upon that in *Burton v. Wilmington*, the U.S. Court of Appeals for the Sixth Circuit, in *Palmer v. Columbia Gas of Ohio*, 479 F.2d 153 (1973) **(EXHIBIT 50G)**, held:

[Sixth Circuit opinion - Begin quote]

STATE ACTION
...
... When a privately owned company enjoying a monopoly is in the business of providing a necessity of life it cannot, for purposes of evaluating its relationship to its customers and to the state in which and under whose control it operates, be considered as an independent, free market, common law competitor.
...
The parties are not upon equal ground. ... The consumer, once taken on to the system, becomes dependent on that system for a prime necessity of business, comfort, health, and even life.
...
Virtually every aspect of this company's operations are subject to the dictates of state statute or to the regulation15 of the Public Utilities Commission ... .
...
The important factor is not the number of statutes and regulations which pertain to the operation of a utility company, but the extent to which the state has reserved power to control the operations of a public utility, and the amount of power given to the utility which is usually reserved to the state.
...
[T]he state has granted to utilities powers not usually possessed by private corporations. ...

In addition, we must consider the fact that the furnishing of natural gas to the citizens ... is a legitimate public function which itself has been held to satisfy the state action requirement; when a public function is performed by a private firm whose freedom of decision making has been restricted by governmental regulation and whose freedom of action has been severely circumscribed, the actions of the otherwise private firm become subject to the constitutional limitations placed upon state action. ... When private individuals or groups are endowed by the state with functions or powers which are of a governmental nature, they become instrumentalities of the state and thus are subject to its constitutional limitations. Evans v. Newton, 382 U.S. 296, 299, 86 S.Ct. 486, 15 L.Ed.2d 373 (1966).

> In summary, inasmuch as the operations of the appellant company are fully circumscribed by an all-encompassing system of state statutes ... and the supervision of the state regulatory authority, and inasmuch as the state ... is significantly involved in virtually every one of the company's activities, including the specific activity complained of, the conclusion that the regulatory activities of the state have insinuated it into a position of interdependence with the company so that it must be recognized as a joint participant with the company is inescapable. Burton, supra, 365 U.S. at 725, 81 S.Ct. 856.
>
> [Sixth Circuit opinion - End quote]
>
> Regardless of which line of analysis is followed pursuant to the *State Action Doctrine*, either that deriving from *Burton*, or that applied in *Jackson*, it is clear that the circumstances in the instant case are such that, in addition to willful acquiescence, there absolutely does exist sufficient involvement, influence, knowledge, and sanctioning by the State in the conduct engaged in by PPL Electric Utilities against the Complainants to establish that PPL has acted under color of law as an agent of an agency of the State and is thereby a 'state actor'.

F. Exhibits of Copies of Letter Communications between Complainants and Respondent, PPL Electric Utilities Corporation

All letter communications exhibits listed below between the Complainants and Respondent were fully identified and explicated in Complainants' Amended Complaint. Their content details specifically the statements which in fact were directed by the Complainants to the Respondent's officers and by the Respondent's officers to the Complainants. These letters therefore should be included as part of the record in this case.

This set of letters includes the following:

LETTER 1A
LETTER 1B
LETTER 1C
LETTER 2
LETTER 3A
LETTER 3B
LETTER 3C
LETTER 3D
LETTER 4A
LETTER 4B
LETTER 4C
LETTER 5

V. Conclusion

WHEREFORE, for the foregoing reasons, Complainants respectfully request:

That this Court thoroughly scrutinize the Complainants' exhibits so as to ascertain the high degree of credibility and probative value of the evidence which they bring forth in support of Complainants' claims in this case,

And that the Court reject Respondent PPL Electric's Motion in Limine.

Respectfully submitted,

Dated: April 16, 2020 ,

John and Janet Holder, Complainants