982 N. 640th Rd., Baldwin City, KS 66006

March 20th, 2014

Declaration of William J. Bruno, Ph.D. regarding DPU Docket 12-76

I, William J. Bruno have personal knowledge of the research literature set forth below in this declaration and am competent to testify thereto if called upon to testify in a court of law. I hereby declare:

- My name is William Bruno and I reside at 982 N. 640th Rd., Baldwin City, KS 66006.
- I am a utility customer of Westar Energy. My mother is a customer of Massachusetts Electric.

1. My mother, two brothers, and sister live in Massachusetts, and this proceeding is extremely important to me as I am convinced it will have implications for their health.

2. I was a top student in science and math at Bedford High School in Bedford, Mass., and went on to earn two bachelor's degrees at M.I.T., one in math, one in physics. In math, I received honorable mention in the national Putnam Exam, and in physics I was one of four finalists for the national Apker award. I then received an NSF Graduate Fellowship which supported me in graduate school at the U.C. Berkeley Department of Physics, where I was awarded a Ph.D. for my thesis on quantum effects in biological systems. I then worked at Los Alamos National Laboratory, where I received a DOE Distinguished Postdoctoral Human Genome Fellowship. I continued working at Los Alamos for over 20 years in the Biology and Biophysics group of the Theoretical Division, attending many international meetings and serving as a temporary advisor to the WHO in Geneva. I also was an invited participant in an International Expert Workshop on Health Effects of Radio-frequency (RF) Fields Health Research, convened by the Electric Power Research Institute (EPRI). I have published several widely cited papers, and altogether my papers have been cited over 2000 times.

3. I disagree with Dr. Valberg's testimony, for the reasons given below:

4. **There is substantial variation in official exposure limits worldwide;** Compared to the FCC limit, China's limit is 100 times lower, and Salzburg Austria's indoor limit is 100,000 times lower than that. The BioInitiative Working Group, a group of scientists who believe the limits should be based on biological experiments, proposed limits 1000 times lower than the FCC's. There have been some experiments reporting effects at levels even lower than that (the most extreme case I know of being old (pre-cellphone era) experiments on human EEG (Bise, 1977) demonstrating effects at less than one billionth of the FCC limit..

5. **There is a vast published literature on non-thermal biological effects**. For example, there are many papers on DNA breakage at non-thermal exposures. It is not true that non-ionizing radiation can never break chemical bonds. What is true is that a single non-ionizing photon cannot break a chemical bond. Chemists have done many experiments on multi-photon effects, where, for example, strong infrared radiation (also considered "non-ionizing") is used to break chemical bonds. Although the microwave fields we are talking about are too weak to do that in free space, or in the homogenized models of biological tissues used to calculate thermal exposure, the fields at the molecular level in real tissue have turned out to be another matter. There are several papers indicating that DNA is an electrical conductor or semiconductor (depending on the local DNA sequence; a Cal Tech professor has proposed that this allows a signaling mechanism to direct repair enzymes to damaged bases), neuromelanin is a conductor, the magnetite particles found throughout the body are conductors, some bacteria make conducting filaments for transferring electrons in electrochemical reactions, and there are experiments showing that porphyrins, which are abundant in certain tissues, can support electron hopping conduction. The fields at the surface of a conductor can be very high, especially at the ends of a one-dimensional conductor. It is easy to imagine that if a DNA molecule had a single-stranded break, the field near such a break might (assuming conductivity requires both strands, as in exciton pair conductivity) be high enough to create a free radical which then might damage the other strand, leading to a double stranded break which is much more difficult to repair. As I said earlier, multiple research groups have reported an increase in such breaks with RF exposure, and there are several papers showing reactive oxygen species (free radicals) being associated with RF exposure. One should also consider the cryptochrome protein, which is known to convert low frequency magnetic fields into nerve signals by altering free radical pair recombination lifetimes. Non-thermal effects at the organism level have been reported in humans (notably effects on sleep EEG), ants, bees, tadpoles, human sperm, and even trees.

6. Although a low duty cycle sounds like it should be less harmful, **there is reason to think that short, sudden pulses can have worse biological effects than continuous exposures**. For example, many people are soothed by the sound of pink

noise, but get irritated by the sound of a dripping faucet. Some people are perfectly normal except when they are exposed to a flashing light within a certain range of flash rates, and then they have a seizure. Experiments by Prof. Frank Barnes (U. Colo., IEEE Fellow) show that very small, pulsed changes in temperature can affect living cells in surprising ways.

7. Although there are more published papers claiming that electrical hypersensitive sufferers cannot detect exposure than those claiming the opposite, **papers that fail to find an effect cannot be used to refute papers that find an effect under different conditions**. There have been at least four papers (Schröttner et al., 2007, Zwamborn et al., 2003, Rea et al., 1991, McCarthy et al. 2011; see also Kwon et al. 2008) reporting on one or several people who could reliably detect weak exposures in double-blind experiments, including one recently on a doctor who is electrically sensitive (McCarthy et al. 2011). A survey of doctors in Switzerland found that, when patients explained their condition of electrical hypersensitivity, their doctors were convinced the cause really was due to electromagnetic exposures in the majority of cases (Huss et al, 2006). Some of the papers claiming the effect is psychological were conducted using an exposure system that continued to expose the person even during the "sham" exposures. One study performed MRI on the patients during both "sham" and actual exposure. The intense RF fields of an MRI make the notion of a sham exposure meaningless, and it surprises me that such an experiment is even ethically allowable. In other experiments important fields like the background power frequency magnetic fields or the RF field in the waiting room were not measured or controlled. Because hypersensitive people often have symptoms like headaches that last much longer than the exposure, such poor experimental design makes some such studies pointless. Studies that found positive results were done under much better conditions, either at the person's home or in a laboratory where reasonable precautions were taken, with proper sham exposures, and in some cases true exposures customized to the subject's determined sensitivity.

8. Although the radiation from a point source or small isolated antenna falls off as the square of distance, this cannot be assumed true in the case of smart meters, particularly regarding the **unintentional radio-frequency emissions** from the built-in switch-mode power supply, **which can travel efficiently on all household wiring and re-radiate throughout the home. This phenomenon has been called "dirty electricity"**. Because many homes have multiple digital gadgets in operation, adding one additional source of dirty electricity is not always going to be noticed. However, the home of an older person, and especially of someone who suffers from electrical hypersensitivity, may have no digital devices plugged in, (particularly at night, when many people unplug devices that draw idle "phantom" current when off; although switch-mode power supplies draw less idle current, the draw is never zero and the RF pulses continue as long as voltage is present at the plug). In such cases, **the effect of adding a single switching power supply can dramatically increase the amount of pulsed RF radiation in a home** (especially if they don't share a transformer with neighbors, or only neighbors who have equally non-dirty electrical devices), and this can easily be illustrated by holding a simple portable AM radio, tuned to static, near any light switch or outlet. More specialized devices, including the Stetzer meter and the MFJ Line Noise Meter, can be used to quantify this effect.

8. Finally, anyone who equates the wattage of a microwave transmitter with the wattage of a light bulb in regards to the possible risk is either very ignorant of the relevant physics, or misleading their audience. It is true that in the paradigm of "no non-thermal effects," the two wattages can be compared, but even the biggest supporters of microwave technology, such as the U.S. Navy, have long admitted that non-thermal effects, such as the Frey microwave hearing effect and the pearl chain effect, do exist. **The most obvious difference between microwaves and visible light in regards to health effects is their penetration depth.** Visible light has a hard time penetrating the skin, which is why we can't see our internal organs. (Note that we have evolved special repair systems in the skin to repair damage from UV light, and this system, at least in some organisms, is activated by the presence of blue light. Also note that light does enter the skull through the eyes, and that at night we need darkness to sleep well. In both cases, evolution has adapted us to survive well in the natural environment, an environment with about a billion times less microwave energy than what many people are exposed to today.) Microwaves penetrate much deeper, which is why they can cook food quickly, and why a small cellphone can still work if you put your hand over the antenna. (Interestingly, in the opposite extreme, where the body and other flesh were perfectly transparent to microwaves, the microwave oven would not work at all, cellphones would be perfectly safe.) Unfortunately, cellphone microwaves are quite good at interacting with tissue deep inside our bodies, including inside the skull. Make their frequency ten times higher and they would be much more absorbed in the water molecules in the skin, ten times lower and they would be much more reflected by ionic currents induced in our cells. Not all "non-ionizing" radiation is created equal.

References

Bise, William. "Low power radio-frequency and microwave effects on human electroencephalogram and behavior." *Physiological chemistry and physics* 10.5 (1977): 387-398.

Huss, Anke, and Martin Röösli. "Consultations in primary care for symptoms attributed to electromagnetic fields–a survey among general practitioners." BMC Public Health 6.1 (2006): 267.

Kwon, Myoung Soo, et al. "Perception of the electromagnetic field emitted by a mobile phone." *Bioelectromagnetics* 29.2 (2008): 154-159.

McCarty, David E., et al. "Electromagnetic hypersensitivity: evidence for a novel neurological syndrome." *International Journal of Neuroscience* 121.12 (2011): 670-676.

Rea W, Pan Y, Sujisawa I, Suyama H, Samadi N, Ross G. Electromagnetic Field Sensitivity Journal of Bioelectricity, (1991) 10 (1&2), 241-256. available at http://www.aehf.com/articles/em_sensitive.html.

Schröttner, Jörg, Norbert Leitgeb, and Lena Hillert. "Investigation of electric current perception thresholds of different EHS groups." *Bioelectromagnetics* 28.3 (2007): 208-213.

Zwamborn APM, Vossen SHJ, van Leersum BJA, Ouwens MA, Makel WN "Effects of Global Communication system radio-frequency fields on Well Being and Cognitive Functions of human subjects with and without subjective complaints." Published in: *TNO Reports* FEL03C148 (2003): 1-89