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To Whom it May Concern:

I appreciate the opportunity to reply on the public health questions raised by the introduction of smart metering technology as a new feature of utility infrastructure.

Essential feature of smart metering – The essential feature of this technology is the use of radiofrequency (RF) transmissions to communicate data between electric, gas, and water utility operators and users at residential and business sites. The simplest system provides automated readout of the electric, gas, or water meter. In addition, advanced systems permit two-way real-time communication with electricity customers for adjustment of power demands. This allows optimization of diverse goals, including energy conservation, cost control, user comfort and safety, and security of service for critical needs. Smart metering involves a multiplicity of new sources of RF transmissions from millions of devices installed throughout the built environment.

Principled public health oversight – As a matter of principled public health oversight, it is appropriate to analyze the potential impact of a widespread increase in RF signals throughout the communities in which people live and work. A thorough analysis of the change in environmental RF exposure caused by smart metering would be based on numerical data for existing public RF exposures and the increment attributable to smart metering. Data of that type are not available, but based on the low operating power of each device and the rapid decline in RF field strength with distance, the overall effect of millions of devices in a metropolitan area would cause little change in background RF energy levels. An analysis of exposures produced near individual smart meters reached the conclusion that "immediately adjacent to a power meter, the RF field power density is less than 10 microwatts per square centimeter (μW/cm^2), which is miniscule compared to the FCC limit of 601 μW/cm^2 for the 902-928 MHz band" (Tell, 2008). Smart meter systems also use "access point" antennas to transmit the aggregated data from thousands of individual meters. These transmitters, typically operating with one watt or less, may be pole-mounted above ground and that distance results in exposures at ground level that are lower than those near a smart meter.

Resemblance to other widely used wireless systems – Smart metering systems operate at frequencies and power levels that resemble those of cellular telephone systems and WiFi nodes (as commonly used for Internet connection in public areas and coffee shops). Cellular telephone handsets and base stations have been examined in depth from engineering, bioengineering, biological, and risk assessment perspectives. The similarity in power levels, operating frequency, and, in approximate terms, spacing of sources, suggests a very small increase over existing environmental RF power density in urban and suburban environments. The low data rates of either read-only systems or active systems that control electricity loads require very low transmission duty cycles from the smart meter, such as one quarter hour or less of actual transmission per day. This low rate of transmission (approximately 1%) further decreases background levels from the system. The conclusions that follow depend strongly on the fact that RF field strength and the energy available for absorption into the body decay rapidly with increasing distance from the source (smart meter). Consequently,

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there can be hundreds or thousands of smart meters nearby, but simple addition does not determine exposure at any one location and the overall increment in exposure remains very small everywhere.

Health hazards of RF energy – Established and undeniable health hazards of RF energy occur when the energy absorbed by the body or a body region is sufficient to increase tissue temperature by several degrees Celsius. Scenarios for thermally hazardous conditions require an RF source of great enough power and, in the case of exposure from an antenna, close proximity to the antenna. Extensive research in animals and detailed biophysical and bioengineering studies show that absorption at the rate of several watts into a kilogram of tissue is required to heat body tissues enough to raise its temperature significantly; a suitable unit for the specific rate of energy absorption is the watt per kilogram (W/kg). Therefore, the thermal hazard of RF energy is generally not a factor when the source cannot produce several watts of power, excepting specialized circumstances, not relevant here, where power is absorbed selectively in a small volume. In addition to transmitted power, frequency (which influences signal transmission and energy absorption) and distance from a source (typically, an antenna) are the other major determinants of the strength of exposure.

Non-thermal effects – The realm of potential effects that might occur without a significant temperature increase, sometimes called "non-thermal" effects, has long been a focus of interest for RF energy safety. One useful benchmark for the biological significance of temperature change is the natural fluctuation in body temperature due to daily rhythms of activity and changes in the external environment. On this basis, many scientists have concluded that harmful effects do not occur with non-thermal exposures, but others remain skeptical because certain laboratory research indicates biological systems may be extraordinarily sensitive to low-power RF energy under non-thermal conditions. However, the overwhelming consensus of scientific panels and government agencies is that potential adverse effects on health require temperature increases of more than one degree Celsius (1 C) in living tissues.

Behavioral disruption as a measure of adverse effect – In pursuit of a biological change other than tissue damage and heat exhaustion that might be a sensitive indicator of RF energy effects, experimenters focused on a disruption in animal feeding behavior that was observable in rats and monkeys exposed to approximately 4 W/kg and higher with an accompanying increase in body temperature of 1 C or more (D'Andrea et al., 2003). Behavioral disruption, with its apparent, but not definitively proven, temperature-related mechanism became the basis for exposure guidelines and standards in the USA and worldwide, including the standard adopted by the FCC that is relevant for smart metering. In this manner, exposure standards are behavior-based, not directly based on a temperature increase, although a temperature increase in some brain or body region presumably is a cause of changes in animal feeding behavior. Note that actual exposure standards are set to levels well below the level for adverse effects in order to have a margin of safety.

Response to the first question – The first question posed is, "Are FCC standards for Smart Meters sufficiently protective of public health taking into account current exposure levels to radiofrequency and electromagnetic fields?" In response to the first part of the question, the answer is yes. In my judgment FCC standards are sufficiently protective because they are set far below the level of known hazards due to heating and below the level of behavioral disruption in laboratory animals.

An unstated accompanying question, which has long been the source of controversy is, "Does RF energy produce biological effects without significant temperature change for exposures below the level of behavioral disruption? Moreover, are such biological effects, if they exist, hazardous or merely a benign physiological effect of no consequence for health?" Examples of benign low-energy physiological effects include the sensation of a breeze on the skin and hearing a weak sound. In the absence of conclusive demonstrations of non-thermal biological effects, the existence of adverse effects in human beings is speculative and in my judgment the probability that such adverse effects can be demonstrated is remote. Correspondingly, Sheppard et al. (2008) conducted an extensive, detailed biophysical analysis of essentially all possible mechanisms for

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biological effects from RF energy. They found that the thresholds for biophysical mechanisms are invariably far above the levels of interest for exposures to smart meters and other low-power devices and systems.

The second part of the question posed has the modifying phrase *"taking into account current exposure,"* which is not clear. If this qualification is meant to limit the scope of the question to current devices using low-power wireless technology with radiated powers of approximately one-watt or less and located at some distance from the body, as for a smart meter antenna located within a meter case or mounted nearby, this qualification would not affect conclusions given below. If, instead, the qualification addresses a comparison of existing RF background energy and the added RF energy from smart metering systems, the considerations offered above indicate that any such increase is very small, far below existing exposure standards, and poses no known biological or health risk.

Epidemiologic research on mobile telephony – Notwithstanding the strong conclusions that can be drawn from laboratory studies and biophysical analysis, the most persuasive evidence for public health determinations often rests with epidemiologic studies of large numbers of human beings obtained over many years. Exposure assessment, that is, exposure information for individuals of the study population, is a frequent and critically important difficulty of epidemiologic studies in general. Exposure assessment is particularly difficult for fast-changing wireless technologies. Comprehensive current evidence does not show health effects related to either hand-held mobile phones (The INTERPHONE Study Group, 2010) or the base stations that exist throughout the community (Kundi and Hutter, 2009), but there are contrary conclusions (Hardell et al., 2009) concerning brain tumors and handheld phones. Research is ongoing and will continue for years into the future.

Response to the second question – Upon consideration of the substantial similarities among smart meter systems, mobile phone systems and WiFi systems with respect to operational powers, frequency, and signal type, and because overall community background exposure to levels remain very low compared to levels permitted by existing standards, there is no evident reason based on RF engineering, biology, biophysics, and human physiology to devise standards specific to the smart meter technology.

A scientifically thorough response to the exposure assessment and public health questions posed by smart metering would require determination of exposures in the environment from a number of specific technologies deployed in various scenarios of networking and terrain, and for special cases such as congested meter placement in a multiple-unit dwelling. In my judgment, despite this gap in exposure data, none of these conditions is likely to demonstrate exposures that would require specialized standards.

Conclusion – Smart metering is a low-power wireless technology that resembles existing technologies such as cell phone and WiFi systems except that individual exposures and community exposures are at lower power densities for smart metering in comparison with mobile telephony. It is highly unlikely that RF exposure to any individual and the population at large would cause adverse health effects; existing FCC standards adequately protect public health; and no additional standards are needed to address the particular technical features of smart metering systems. There is, however, a data gap because of the absence of modern data on existing community environmental exposures to RF energy and the increment caused by widespread adoption of new wireless technologies, such as smart metering.

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Sincerely yours,

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