

Understanding Radio-Frequency and Health Impacts

Introduction:

There has been increased concern amongst Cooper Power Systems energy consumers regarding the possible health effects of Smart meter radio communication and other wireless technology. Cooper Power Systems takes the customer concerns of our AMI users seriously and, after analysis of the issue, would like to affirm that decades of scientific evidence, reinforced by recent specific radio frequency (RF) exposure evaluations, conclude that RF transmissions of the type associated with Smart meters is highly unlikely to cause adverse health effects.

Evidence:

According to the U.S. Federal Communications Commission (FCC), the organization with oversight responsibility for RF safety guidelines, devices which emit radio energy must be certified to meet maximum permissible exposure (MPE) requirements, as specified in FCC 1.1310. The limits specified by the FCC vary based on frequency and the power density limits are specified as an average value over a 6 minute time period. The power density limit for the 902-928 MHz band in which the Cooper RF AMI products operate (defined as the 915 MHz Industrial, Scientific and Medical band) is 0.6 mW/cm². The FCC validates a device using a calculation distance of 20 cm (7.9 in.) and notes RF exposure drops rapidly with distance.

Note 1: The FCC limits for exposure are based on the effects of tissue heating in behavioral studies in animal subjects and afford the public a margin of safety 50-fold lower than the adverse effect exposure threshold¹.

Note 2: Other organizations that recommend exposure limits, including the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Institute of Electrical and Electronic Engineers (IEEE), have also adopted guidelines consistent with the FCC's.

The California Council on Science and Technology (CCST) an independent organization, sponsored in part by the state's major universities and federal laboratories, conducted a data analysis review, titled "Health Impacts of Radio Frequency from Smart Meters" to assess the potential health effects of smart meter operation. Upon completion of the study, CCST published Table 1 below outlining what the organization believes are the key factors when evaluating exposure to radio frequency from smart meters.

Table 1: Key Factors When Evaluating Exposure to Radio-Frequency from Smart Meters

1. Signal Frequency	Compare to devices in the 900 MHz band and 2.4 GHz band	Frequency similar to mobile phones, Wi-Fi, laptop computers, walkie-talkies, baby monitors, microwave ovens
2. Signal Strength (or Power Density)	Microwatts/square centimeter (μW/cm ²)	Meter signal strength is very small compared to other devices listed above
3. Distance from Signal	Signal strength drops rapidly (doubling distance cuts power density by four)	Example: 1 ft. – 8.8 μW/cm ² 3ft. –1.0 μW/cm ² 10ft.–0.1 μW/cm ²
4. Signal Duration	-Extremely short amount of time (2.0---5.0%, max.)	-Often overlooked factor when comparing devices.

¹ A 2009 review of the radio-frequency health literature conducted by the International Commission on Non-Ionizing Radiation Protection concluded, "The mechanisms by which RF exposure heats biological tissue are well understood and the most marked and consistent effect of RF exposure is that of heating, resulting in a number of heat-related physiological and pathological responses in human subjects and laboratory animals...Whilst it is in principle impossible to disprove the possible existence of non-thermal interactions, the plausibility of various non-thermal mechanisms that have been proposed is very low..."

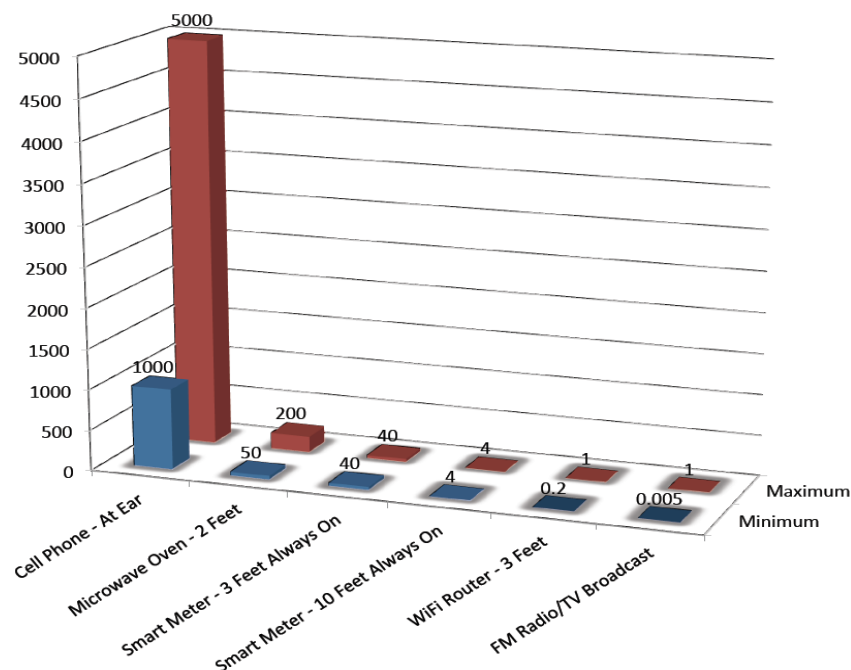
	-No RF signal 95-98% of the time (over 23 hours/day)	-Short duration combined with weak signal strength yields tiny exposures
5. Thermal Effects	Scientific consensus on proven effects from heat at high RF levels	FCC “margin-of-safety” limit is 50 times lower than hazardous exposure level -Typical meter operates at 70 times less than FCC limit and 3,500 times less than the demonstrated hazard level
6. Non-thermal Effects	-Inconclusive research to date -No established cause-and-effect pointing to negative health impacts	Continuing research needed

Source: California Council on Science and Technology, “Health Impacts of Radio Frequency from Smart Meters,” January 2011, page 25.

In relation to other commonly used devices, such as cell phones, microwaves, and lap tops, the relative power density of smart meters is minimal and much lower than the FCC standard. Furthermore, in most cases the meter is placed outside of the home (providing additional exposure screening) and operates for shorter periods of time (generally for a few seconds at a time with transmissions occurring at different times throughout the day). The very low duty cycle operation of the meters therefore limits potential exposure and decreases the possible threat to the customer’s health.

CCST looked at data showing radio frequency levels from various common household items in comparison to smart meters. The findings are shown below in Figure 1.

Figure 1: Comparison of Radio-Frequency Levels from Various Sources (in $\mu\text{W}/\text{cm}^2$)



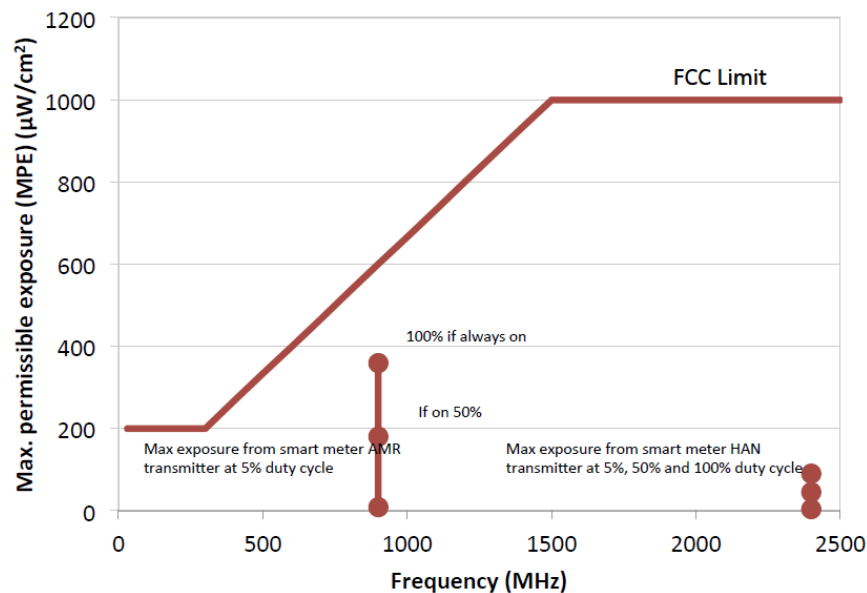
Source: California Council on Science and Technology, “Health Impacts of Radio Frequency from Smart Meters,” January 2011, page 20.

This data shows that the maximum RF exposure effects from an **always-on** (100% transmit duty cycle) smart meter at 3 feet is one fifth that experienced from a microwave at 2 feet. The maximum possible transmit duty cycle for a normally functioning RF smart meter is 50% where data transmissions and receptions alternate. The actual transmit duty cycle is dependent on the meter’s location within the network – increasing for devices that are closer to the Gateway collectors if they support a large amount of relay traffic. For current deployed networks the average smart meter transmit duty cycle is typically less than 5% and may be as low as 1-2%. The CCST data presented above thus assumes an extreme worst case scenario of a malfunctioning meter that is stuck

transmitting continuously with a resulting 100% duty cycle. Even under such an extreme assumption the worst case exposure is still a fraction of that experienced from microwave oven usage. A user will also have far more interactions with a microwave at 2 feet than with continuous presence 3 feet from a malfunctioning (always-on) smart meter.

In figure 2, to further demonstrate the minimal impact of a smart meter, the CCST outlines the FCC’s maximum exposure limits in comparison to exposure amounts from a typical smart meter. The graph is indicative of just how safe smart meters really are with regard to RF exposure.

Figure 2: FCC Maximum Exposure Limits and Exposure from a 900 MHz, 1 Watt smart meter 1 ft from the user



Source: California Council on Science and Technology, “Health Impacts of Radio Frequency from Smart Meters,” January 2011, page 18

This data is based on a 1-foot distance from the smart meter with a 1 Watt power transmission. One Watt is the maximum FCC permitted 900 MHz ISM band meter transmit power. As previously indicated, the 100% duty cycle is conservative in that it is based on an assumed failure case in which the meter was stuck continuously transmitting. Since the average meter in a Cooper RF mesh network is likely to be operating with a transmit duty cycle less than 5%, the resulting exposure level, even for a user situated as close as 1 foot, will be far below the maximum level permitted by the FCC.

Table 2 provides a tabular representation of the results of the RF exposure assessment from smart meters and other common user devices as cited within the California Council on Science and Technology study. The data is based on measurements conducted at a manufacturer’s production and test site as part of a study carried out by the Electric Power Research Institute (EPRI).

As the previous graphic illustrated, the exposure due to smart meters at 3 or 10 feet is indeed a small fraction of that received from other common user devices such as cell phones and microwave ovens.

Table 2: Radio-Frequency Levels from Various Sources

Device	Frequency	Exposure Level (mW/cm ²)	Distance	Exposure Time	Spatial Characteristic
Cell phone ⁽¹⁾	900MHz, 1800 MHz	1-5	At ear	During call	Highly localized
Cell phone base station ⁽²⁾	900MHz, 1800 MHz	0.000005-0.002	10s to a few thousand feet	Constant	Relatively uniform
Microwave oven ⁽³⁾	2450 MHz	~5 0.05-0.2	2 inches 2 feet	During use	Localized, non-uniform

Local area networks ⁽⁴⁾	2.4-5GHz	0.0002-0.001 ^a 0.000005-0.0002 ^b	3 feet	Constant when nearby	Localized, non-uniform
Radio/TV broadcast ⁽⁵⁾	Wide spectrum	0.001 (highest 1% of population) 0.000005 (50% of population)	Far from source (in most cases)	Constant	Localized, non-uniform
Smart Meter ⁽⁶⁾	900MHz, 2400 MHz	0.0001 (250mW, 1% duty cycle) 0.002 (1 W, 5% duty cycle) 0.000009 (250mW, 1% duty cycle) 0.0002 (1 W, 5% duty cycle)	3 feet 10 feet	Only when in proximity during transmission	Localized, non-uniform

Source: Electric Power Research Institute (EPRI), "Radio Frequency Exposure Levels from Smart Meters," November 2010, page 7.

a-wireless router b-client card

(1) Based on a 3-inch, 250 mW antenna emitting in a cylindrical wavefront.

(2) Elliott P, Toledano MB, Bennett J, Beale L, de Hoogh K, Best N, Briggs DJ. 2010. "Mobile phone base stations and early childhood cancers: case-control study. BMJ 340:c3077."

ICNIRP. 2009. "Exposure to high frequency electromagnetic fields, biological effects and health consequences (100 kHz-300 GHz)." International Commission on Non-Ionizing Radiation Protection, Oberschleißheim, Germany, page 14.

Ramsdale PA, Wiener A. 1999. "Cellular Phone Base Stations: Technology and Exposures." Radiat Prot Dos 83:125-130.

(3) ICNIRP. 2009. "Exposure to high frequency electromagnetic fields, biological effects and health consequences (100 kHz-300 GHz)." International Commission on Non-Ionizing Radiation Protection, Oberschleißheim, Germany, page 21.

Tell RA. 1978. "Field-strength measurements of microwave-oven leakage at 915 MHz." IEEE Trans Electromagnetic Compatibility 20:341-346. R.A. Tell, personal communication.

(4) Wireless router based on 30-100 mW isotropic emitter.

Client card based on: Foster KR. 2007. "Radiofrequency exposure from wireless LANs utilizing Wi-Fi technology." Health Phys 92:280-9.

(5) Tell RA, Mantiply ED. 1980. "Population Exposure to VHF and UHF Broadcast Radiation in the United States." Proc IEEE 68:6-12.

(6) Based on spatial peak power density with 6 dB (x4) antenna gain.

Conclusion:

Cooper Power Systems values our energy customers, their service concerns, and their health. Cooper RF products meet and exceed the FCC certification requirements for operating within the ISM band and are further reassured by recent, continued assessments demonstrating the very limited potential RF exposure caused by smart meters. The exposure analyses confirms the very low impact of smart meter RF transmissions relative even to other more prevalent RF-transmitting household devices that are considered safe. Even under the extreme assumption of close user proximity to a malfunctioning continuous transmitting device, the resulting RF exposure does not rise to a level that creates a human health concern.

U.S. utilities have been installing meters with radios for remote meter reading since the 1980's. There are now over 50 million of these devices installed and operating in the US without a documented health issue. Additionally, due to the fact that smart meters emit radio frequencies intermittently and at much lower levels than many other safe RF-emitting devices, there is currently no demonstrated risk to the user. Cooper is committed to continuing to monitor the technical and health assessments associated with smart meter operation and in adhering to the regulatory requirements and certifications to ensure that our products do not pose a health risk to utility customers.

Experts concur (see below)—Smart meters pose less of a health risk than many other household items.

California Council on Science and Technology: "Wireless smart meters, when installed and properly maintained, result in much smaller levels of radio frequency (RF) exposure than many existing common household electronic devices, particularly cell phones and microwave ovens."

Maine Center for Disease Control: concluded there is "no consistent or convincing evidence to support a concern for health effects related to the use of radio frequency in the range of frequencies and power used by smart meters."

Additional Resources:

- [Health Impacts of Radio Frequency from Smart Meters](#)
- [No Health Threat from Smart Meters](#)
- [DRSG Radio Frequency & Smart Meters Q&A](#)
- [Assessment of Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields](#)
- [Electric and Magnetic Fields Associated with the Use of Electric Power Q&A](#)
- [FCC Radio Frequency Safety FAQ Website](#)

Sources:

California Council on Science and Technology, "Health Impacts of Radio Frequency from Smart Meters," January 2011

<http://www.ccst.us/publications/2011/2011smartA.pdf>

Electric Power Research Institute, "Radio-Frequency Exposure Levels from Smart Meters," November 2010

<http://www.marbleheadelectric.com/EMF.pdf>

Federal Communications Commission: <http://transition.fcc.gov/oet/rfsafety/rf-faqs.html>, December 2011

Maine Center for Disease Control, "Executive Summary of Review of Health Issues Related to Smart Meters," November 8, 2010,

http://www.maine.gov/dhhs/boh/documents/Smart_Meters_Maine_CDC_Executive_Summary_11_08_10.pdf