



April 18, 2012

To: Patrick Hudson, Michigan Public Service Commission

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Subject: Review of the April 12, 2012 American Academy of Environmental Medicine (AAEM) submittal to the Michigan Public Service Commission.

In response to your request, we reviewed the Michigan Public Service Commission (MPSC) AAEM submittal² to the Docket for Case 17000. Consistent with our prior assistance on a similar submittal our review focuses on the logical foundation of the AAEM statements and relevance of their citations to the smart meter issues. We do not comment on the technical merits of the individual research citations.

1. Key AAEM Issue – Research establishes causality

The American Academy of Environmental Medicine (AAEM) is an organization of environmental medicine specialists. In their submittal to the MPSC they note that “. . . many studies demonstrate that significant harmful biological effects occur from non-thermal RF exposure and satisfy Hill’s criteria of causality. This means that there is a cause and effect relationship between RF emissions, which are the emissions from ‘Smart Meters’, and adverse health effects.”

As noted in our previous review of smart meter health-related issues, radio frequency (RF) represents a wide range (3 kHz to 300 GHz) of radio waves. The RF range cannot be generalized down to a single signal. RF is distinguished by a variety of independent characteristics, including frequency and intensity. This means that an RF effect reported at one frequency from one source cannot be presumed to imply an effect at another frequency from an entirely different source. Similarly, an effect at a given intensity cannot *a priori* be assumed to translate to an effect at intensity. Existing research, including the AAEM citations, emphasize the unique characteristics and potential differences in effects from various RF signals and sources. For thermal effects from RF the assumed mechanism is energy deposition, so a thermal effect at a lower intensity could imply a larger effect might be seen at a higher intensity but not necessarily the reverse. However, non-thermal effects appear to be related to distinct characteristics of the biological system being exposed, where symptoms or effects appear at specific frequencies, or at distinct combinations of fields, but not at others. To the best of our knowledge, there are no clear mechanisms identified for non-thermal RF effects, so there is no basis on which to extrapolate from one source of observed non-thermal effect to another.

The AAEM submittal includes a reference to a paper by ‘Hill’ (citation #3) and a number of peer-reviewed research studies whose results they extend to smart meters. In 1965, Austin Bradford Hill detailed nine criteria for assessing evidence of causation, sometimes referred to as Hill’s criteria³, which are used to extend research from one area to other related areas. Hill’s criteria are most often used in

¹ The Smart Grid Technical Advisory Project provides technical assistance and training to state regulatory commissions on topics related to Smart Grid. The Smart Grid Technical Advisory Project does not get involved in litigated or contested regulatory or other proceedings.

² <http://efile.mpsc.state.mi.us/efile/docs/17000/0391.pdf>

³ Hill, Austin Bradford (1965). "The Environment and Disease: Association or Causation?". *Proceedings of the Royal Society of Medicine* **58** (5): 295–300

epidemiology studies to test whether a particular agent is the cause of a selected effect when it is difficult to control for all experimental variables (so causative agents must be inferred from observational data). However, inference is not proof. Hill's criteria cannot be applied when there are no research related observational results. Further, it is inappropriate to presume an effect when the sources differ in terms of their frequency, intensity, proximity to critical biological tissues, etc.

The table below lists and briefly defines each of the nine Hill's criteria and then compares their application to two different sources of RF exposure; cell phones and smart meters.

Hill Criteria	Cell phones	Smart Meters
Strength: How large is the effect?	No widespread disease has yet been reported.	No published, peer-reviewed, scientific research at this time.
Consistency: Has the same association been observed by others, in different populations, using a different method?	Limited evidence from INTERPHONE study, interpreted differently by different researchers. Opponents of Smart Meters focus strictly on Hardell's positive results without acknowledging the other results in the INTERPHONE study.	No published, peer-reviewed, scientific research at this time. ⁴
Specificity: Does altering only the cause alter the effect?	A variety of studies have looked at changes in experimental setup to alter the source or size of the exposure with compelling results, most of which are related to distinct endpoints (e.g. oxidative stress markers and pathological changes in brain tissue in AAEM citation 16)	No published, peer-reviewed, scientific research at this time.
Temporality: Does the cause precede the effect?	Hard to discern in some epidemiology studies because hard to know state of individuals prior to study. Generally well controlled in lab studies.	No published, peer-reviewed, scientific research at this time, although some people claim a particular set of symptoms arise shortly after meters are installed.
Biological gradient: Is there a dose response?	Intensity of fields is often assumed as dose in a thermal model. For non-thermal effects, these criteria may not apply until we have a better understanding of dose.	No published, peer-reviewed, scientific research at this time.
Plausibility: Does it make sense? (Hill noted that knowledge of the mechanism is limited by current knowledge).	Mechanisms have not been well developed other than heating processes, where it is assumed that energy accumulates until dissipated.	No published, peer-reviewed, scientific research at this time.
Coherence: Does the evidence fit with what is known regarding the natural history and biology of the outcome?	Limited coherence – many of the reported effects have unknown etiologies.	No published, peer-reviewed, scientific research at this time.
Experiment: Are there any clinical studies supporting the association?	There are some studies suggesting effects under certain circumstances.	No published, peer-reviewed, scientific research at this time.
Analogy: Is the observed association supported by similar associations?	Presumed to be supported by earlier (generally higher power) microwave studies.	Presumed to be supported by cell phone studies.

⁴ For the purposes of the Hill criteria, reported symptoms need to be derived from well structured research, not self-reported anecdotal reports (e.g. Internet blogs, newspaper articles, complaints/statements to regulatory commissions, etc.).

Cell phones were selected for this comparison because their RF exposure characteristics and research results are associated with smart meters by AAEM citation and by groups concerned with smart meter RF exposure. It is instructive to use this framework to consider the available evidence: based on our judgment, the Hill's criteria have not been satisfied for smart meters, regardless of how well they may or may not be satisfied for cell phones. This is due to significant technical differences between cell phones and smart meters and the absence of research that specifically addresses smart meter operating characteristics.

2. AAEM Research citations and references are unrelated to smart meters

Smart meters operate in the frequency range 902-928 MHz with an intensity of 1W or less. The references cited in the AAEM submittal appear to be for frequencies and exposures that are substantively different than the very small fields measured from smart meters. Specifically, the references cited in AAEM submittal can be divided into several categories:

- A. General review of a topic or a literature review (citations: 1, 5, 6, 13, 27)
- B. Reports of effects using frequencies related to smart meters (citation: 9)
- C. Reports or studies using specific frequencies not related to smart meters (citations: 4, 7, 8, 10, 11, 22, 23, 24, 25, 26, 28, 30, 31)
- D. Reports of effects from cell phones (citations: 14, 15, 16, 17)
- E. Reports of effects from mobile phone base stations (citations: 18, 19, 20)
- F. Other references or sources unrelated to smart meters (citations: 3, 12, 21, 29).
- G. Actual measurements of fields from smart meters (citation: 2)

AAEM reference and notes by citation.

1. (CCST report) – review of available literature and conclusions
2. (EPRI, 2011) – report of field measurements associated with one model of smart meter
3. (Hill, 1965) – causation criteria
4. (Xu et al., 2010) – effect reported at **1800 MHz**
5. (Phillips et al., 2009) – review
6. (Ruediger, 2009) – review
7. (Zhao et al., 2007) – effect reported at **1900 MHz**
8. (Lee et al., 2005) – effect reported at **2450 MHz**
9. (Demsia, 2004) – effect reported at **910 MHz**
10. (Lai and Singh, 2004) – effect reported at **60 Hz**
11. (Mashevich et al., 2003) – effect reported at **830 MHz**
12. (Magras and Xenos, 1997) – effect reported in an “antenna park” – no identified frequency
13. (Baan et al., 2011) – report on IARC decision (as noted earlier, this reflects the present state of science, not causation)
14. (Hardell et al., 2005) – epidemiology study of **cell phone effects**
15. (Nittby et al., 2009) – effect reported from **GSM-900 mobile phone frequencies**⁵

⁵ uses 890–915 MHz to send information and 1805–1880 MHz for the downlink. Duplex spacing is 95 MHz.

16. (Awad and Hassan, 2008) – effect reported from **900 MHz cell phone attached to head of rats**, with exposures of 1 hr/day over one week and two weeks vs control.
17. (Leszczynski and Joenvaara, 2002) – effect reported from **GSM-900 mobile phone frequencies**⁶
18. (Abdel-Rassoul et al., 2007) – case control study (n=85) of people living near **mobile phone base station**
19. (Santini et al., 2002) – responses to questions posed to males living near **mobile phone base stations**
20. (Hutter et al., 2006) – subjective symptoms, vicinity of **mobile phone base stations**.
21. (Kolodynski and Kolodynska, 1996) – symptoms of school children living near a **radio location station**
22. (Rea et al., 1991) – first reported electromagnetic hypersensitivity testing using square wave frequencies from **0.1 Hz to 5 MHz**
23. (McCarty et al., 2011) – electromagnetic hypersensitivity at **60 Hz**
24. (Ingole and Ghosh, 2006) - **900 MHz, 2 W**, (SAR 0.37W/Kg) results strongly dependent on dose
25. (Lubec et al., 1989) – effects on milk proteins from microwave oven, **2450 MHz**
26. (Smith, 2004) – review to correlate frequencies with acupuncture meridian points
27. (Smith, 2008) – review of Herbert Frolich’s work, not related to smart meter frequencies
28. (Del Giudice, 1989) – review of effect at **7.5 – 8 MHz** (many scientists are quite dubious of this)
29. (Tonomura et al., 1986) – phase shift of two electron beams under very specific conditions requiring superconducting shielding
30. (Del Giudice, 2005) – see #28
31. (Cardella et al., 2001) – reported effects at **379 MHz** and **384 MHz**.

The only reference that included a frequency within the range used by smart meters was citation #9. Unfortunately, the Demisia study (#9) used “*animals . . . exposed for 2 hours/day for 30 consecutive days to a continuous 910-MHz EMF in specially designed Plexiglas cages. Animals were restricted from free movements in order to be equally exposed to the EMF energy. The cages were placed at a distance of 5 mm from a $\lambda/2$ emitting antenna. During the experimental procedure, the maximum SAR value using the Finite Difference Time Domain (FDTD) analysis was calculated and found to be 0.42 W/Kg (10 g) of body weight.*” The reported SAR (Specific Absorption Rate) suggests much higher field strength than that used by smart meters. In addition, the proximity of the tested animals to the EMF source might be physically impossible to accomplish with a normal wall-mounted smart meter.

3. Electromagnetic hypersensitivity

It is also important to note that there are two problems with the AAEM claim that “*Electromagnetic field (EMF) hypersensitivity has been documented in controlled and double blind placebo controlled conditions, 100% of subjects showed reproducible reactions to that frequency to which they were most sensitive.*”⁷ First, there are documented disagreements to this reproducibility, and second, Cyril Smith, cited twice by AAEM in connection with electromagnetic hypersensitivity studies, notes in his overview

⁶ uses 890–915 MHz to send information and 1805–1880 MHz for the downlink. Duplex spacing is 95 MHz

⁷ Ibid. 2, pg.4

of the field that “*The frequencies involved in living systems are very precise, so much so that even the phase of a frequency matters.*”⁸ Therefore, no extrapolation from another frequency is appropriate.

A detailed meta-analysis of available literature⁹ found “*no evidence of an improved ability to detect EMF in ‘hypersensitive’ participants.*” This is further reinforced by the World Health Organization examination of electromagnetic hypersensitivity (EHS) that concludes “*Well controlled double-blind studies have shown that symptoms were not correlated with EMF exposure.*”¹⁰

More importantly, the references cited by AAEM to describe particular frequency sensitivities among self identified electromagnetic hypersensitive individuals (citations 22, 23, and 26) identify a large number of very specific frequencies, none of which is related to smart meter operations.

4. The radiofrequency environment

According to recent measurements¹¹, smart meters contribute a small fraction of the total RF emissions in a typical environment. Eliminating smart meters entirely would produce a minimal reduction in total existing RF exposures to which the general population is routinely exposed.

⁸ <http://hpathy.com/scientific-research/homeopathy-%E2%80%93-how-it-works-and-how-it-is-done-1/>

⁹ Rubin et al., Electromagnetic Hypersensitivity: A Systematic Review of Provocation Studies, *Psychosomatic Medicine* 67:224–232 (2005)

¹⁰ World Health Organization, ‘Electromagnetic fields and public health’, Electromagnetic hypersensitivity, Fact Sheet N^o296, December 2005. <http://www.who.int/mediacentre/factsheets/fs296/en/>

¹¹ “Smart Meters, Household Equipment, and the General Environment,” City of Naperville, Naperville Smart Grid Initiative (NSGI), Pilot 2 RF Emissions Testing – Summary Report – V2.0, November 10, 2011