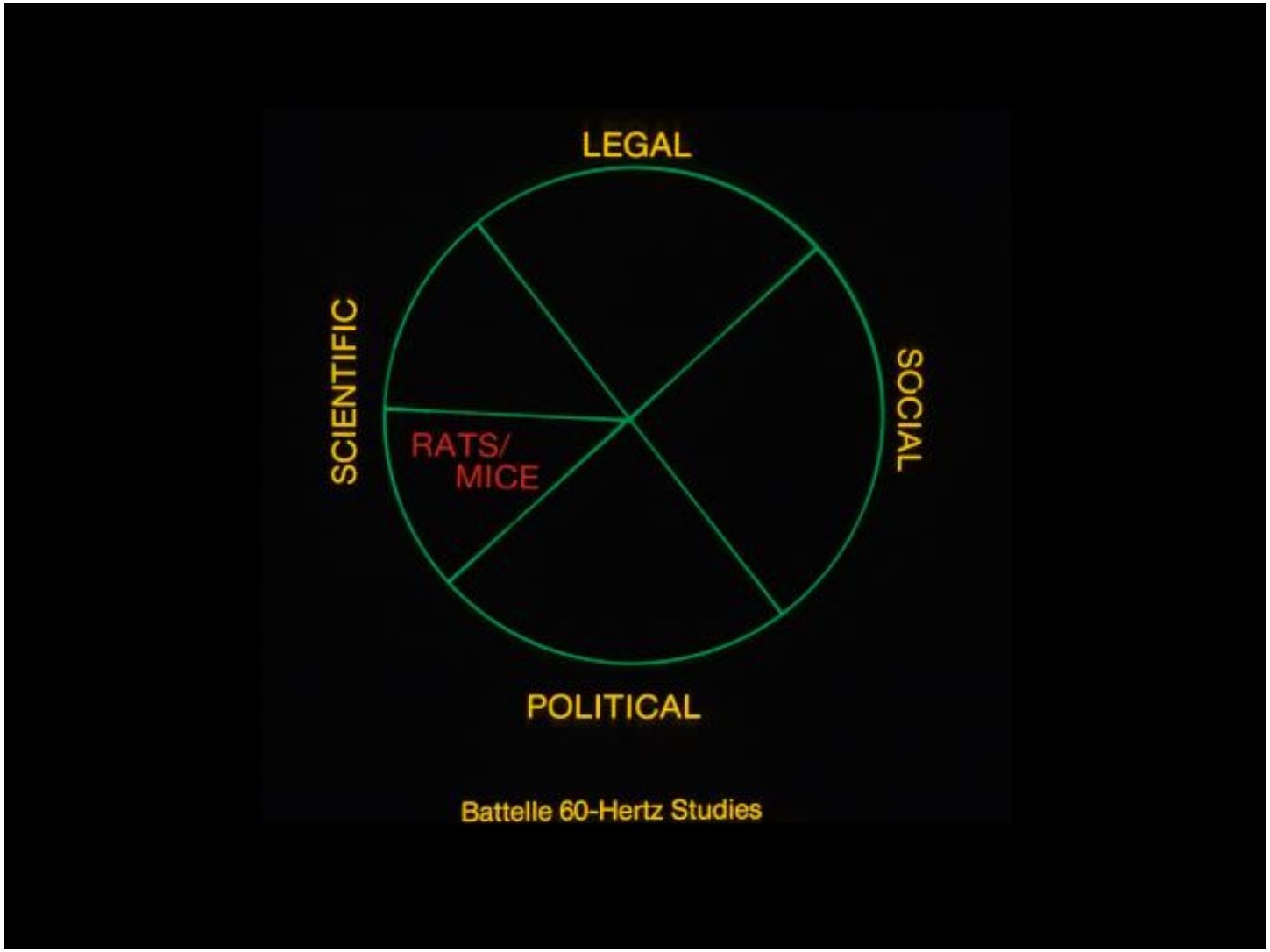
Analysis of Battelle 60-Hz Studies

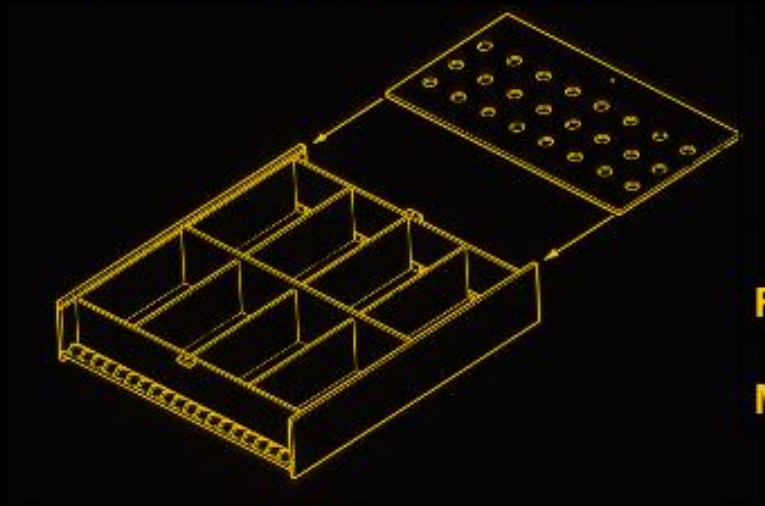


For more than 8 years, investigators at Battelle have been intimately involved in a complex process of assessing the potential health hazards of high-voltage powerlines. During this time, many experiments were conducted at Battelle involving rats, mice, and pigs. In my talk today, I will concentrate on the experiments involving rats and mice.

My conclusion today will be that, measured against the aims stated by the Battelle investigators, their experiments have failed.

Ceiling Height for Animal Housing

Battelle Animal Housing Module

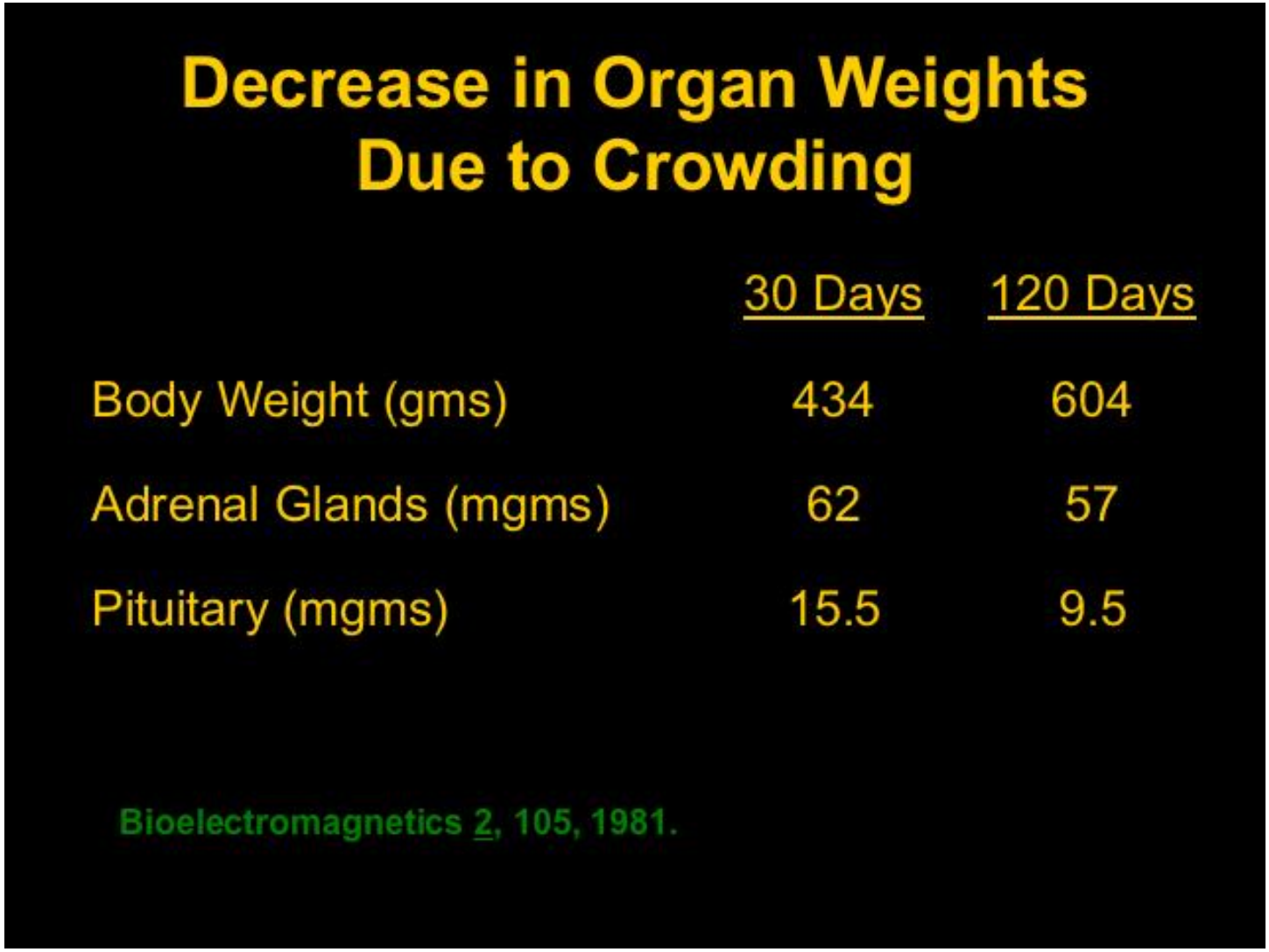


Ceiling Height (Inches)

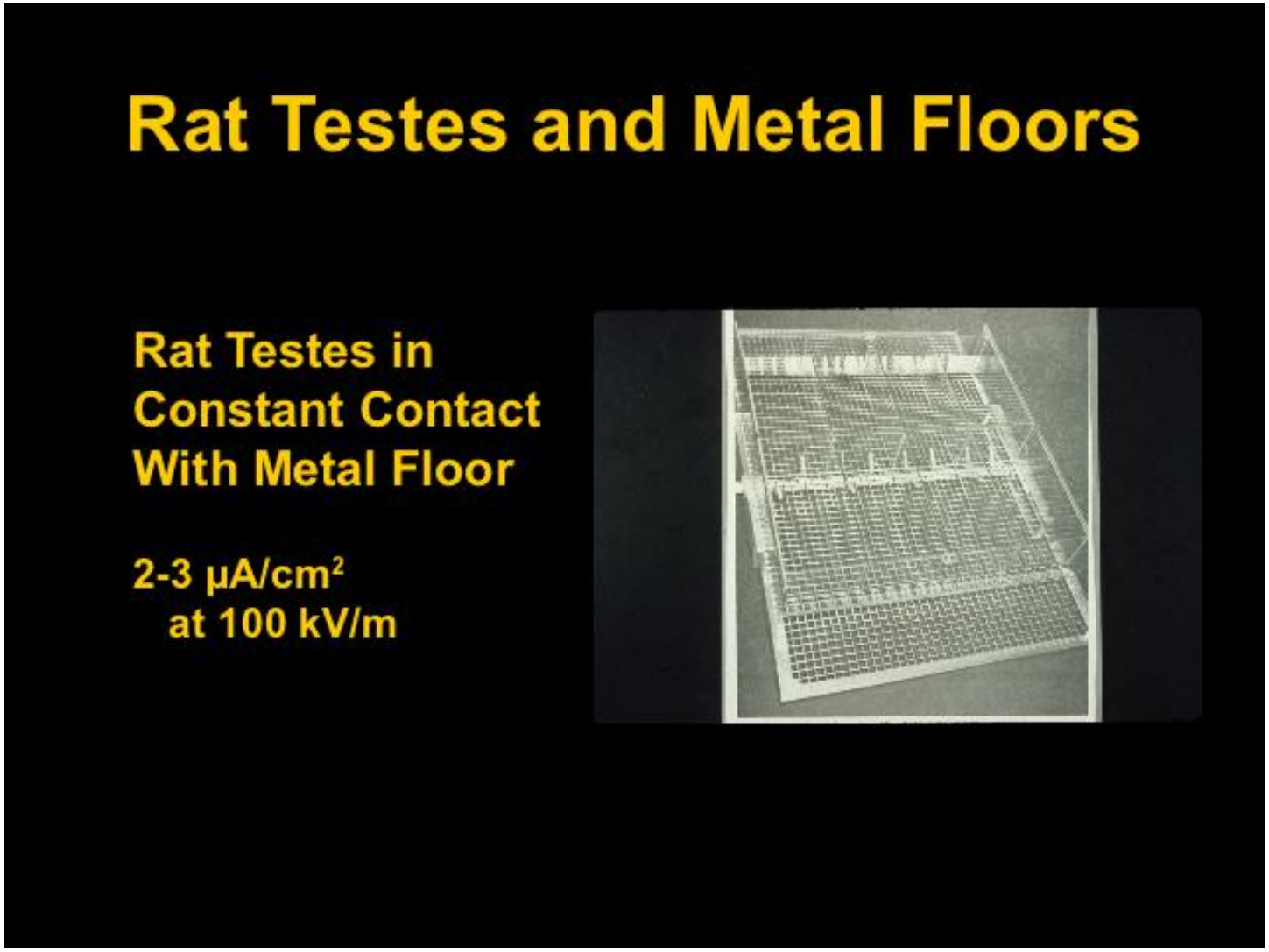
	Battelle Housing Module	NIH Guidelines
Rat	4	7
Mouse	2	4

To perform their rodent experiments, Battelle investigators designed and built modules for housing their animals. Each unit housed 8 animals, and the ceiling height was chosen to prevent them from standing erect. But these ceiling heights violated NIH guidelines for laboratory animals, which called for a minimum of 7 inches for the ceiling height of rat cages, and a minimum of 5 inches for the ceiling height of mouse cages. The NIH guidelines were intended to provide a comfortable environment for the animals, free of any chronic stress that could lessen or even destroy their value as experimental subjects.

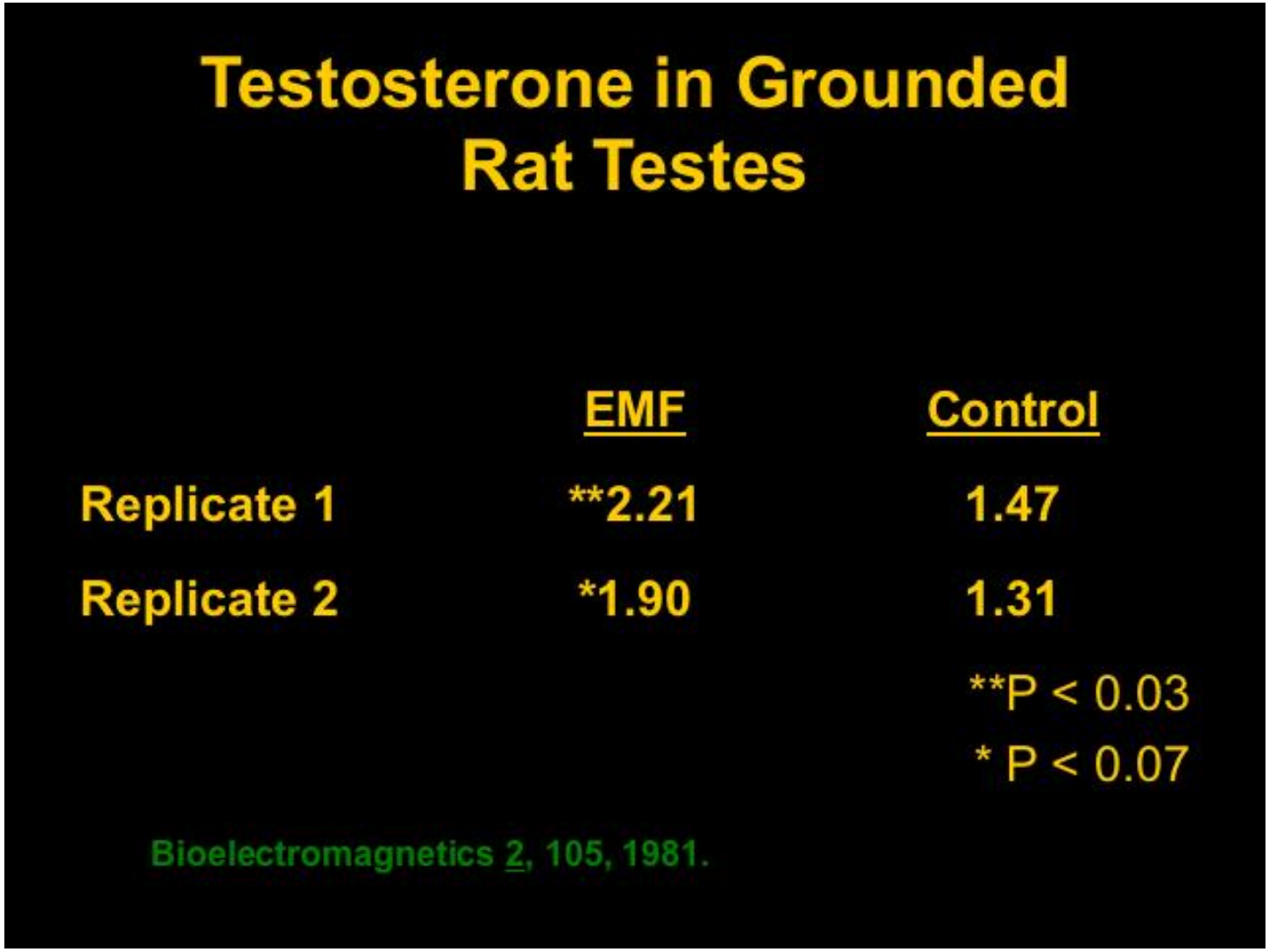
This is a typical rat in one of Battelle's experiments. They were big, and they lived in small boxes. These conditions are not appropriate for asking whether EMFs are stressors. It's like experimenting on the people who lived in the Warsaw ghetto.



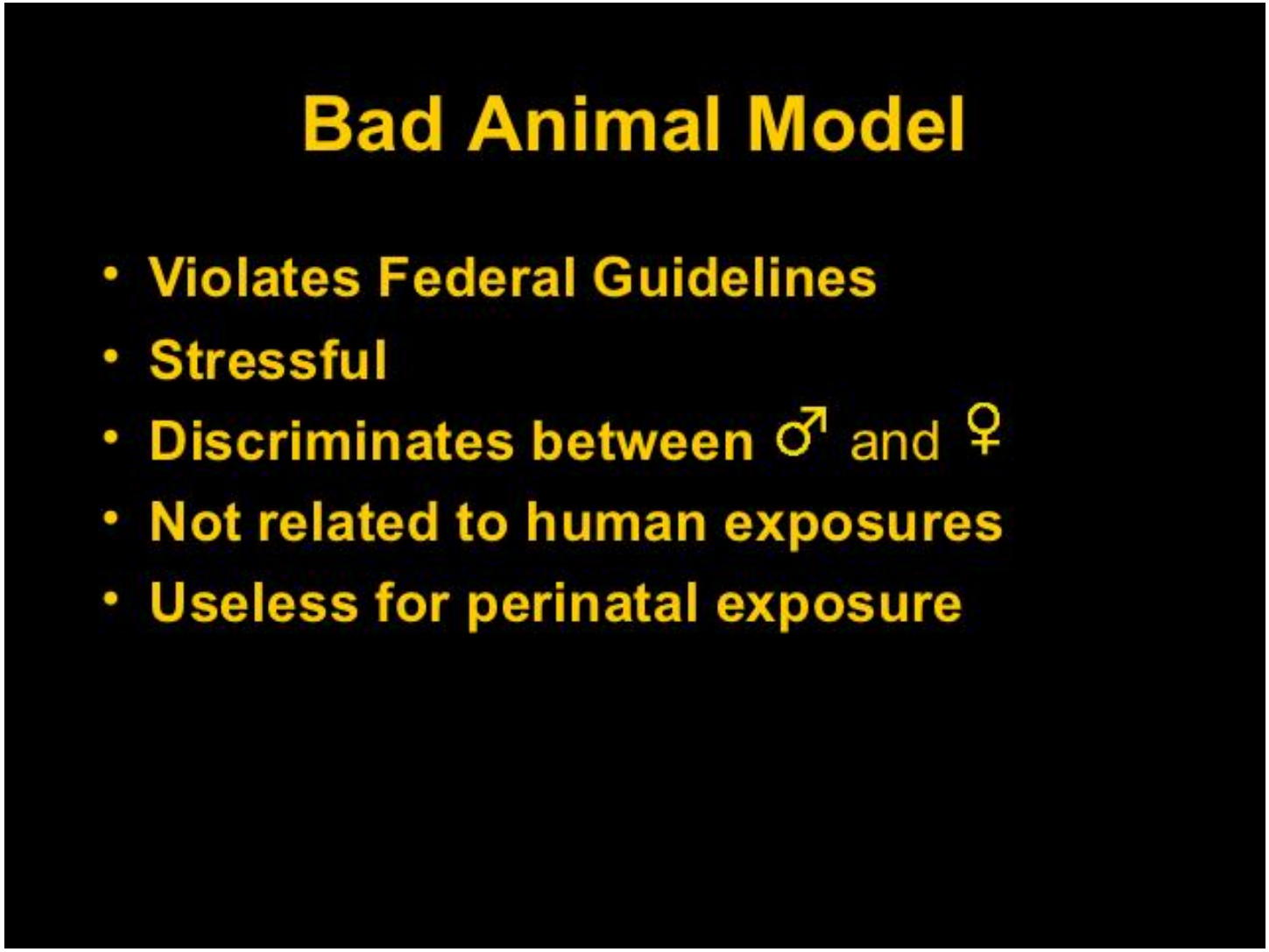
Battelle's failure to follow the NIH guidelines resulted in exactly the kind of housing-induced stress effects that the Guidelines were designed to avoid. For example, rats confined in the Battelle housing units for 120 days had increased body weight compared with their weight after 30 days in the units. But the average weights of the adrenal and pituitary glands of the 120-day rats actually decreased, indicating that the rats were seriously stressed due to chronic crowding. Animals subjected to such chronic crowding are simply not suitable subjects for use in EMF studies because the stress produced by the crowding almost guarantees that the animals will be unresponsive to the EMFs.



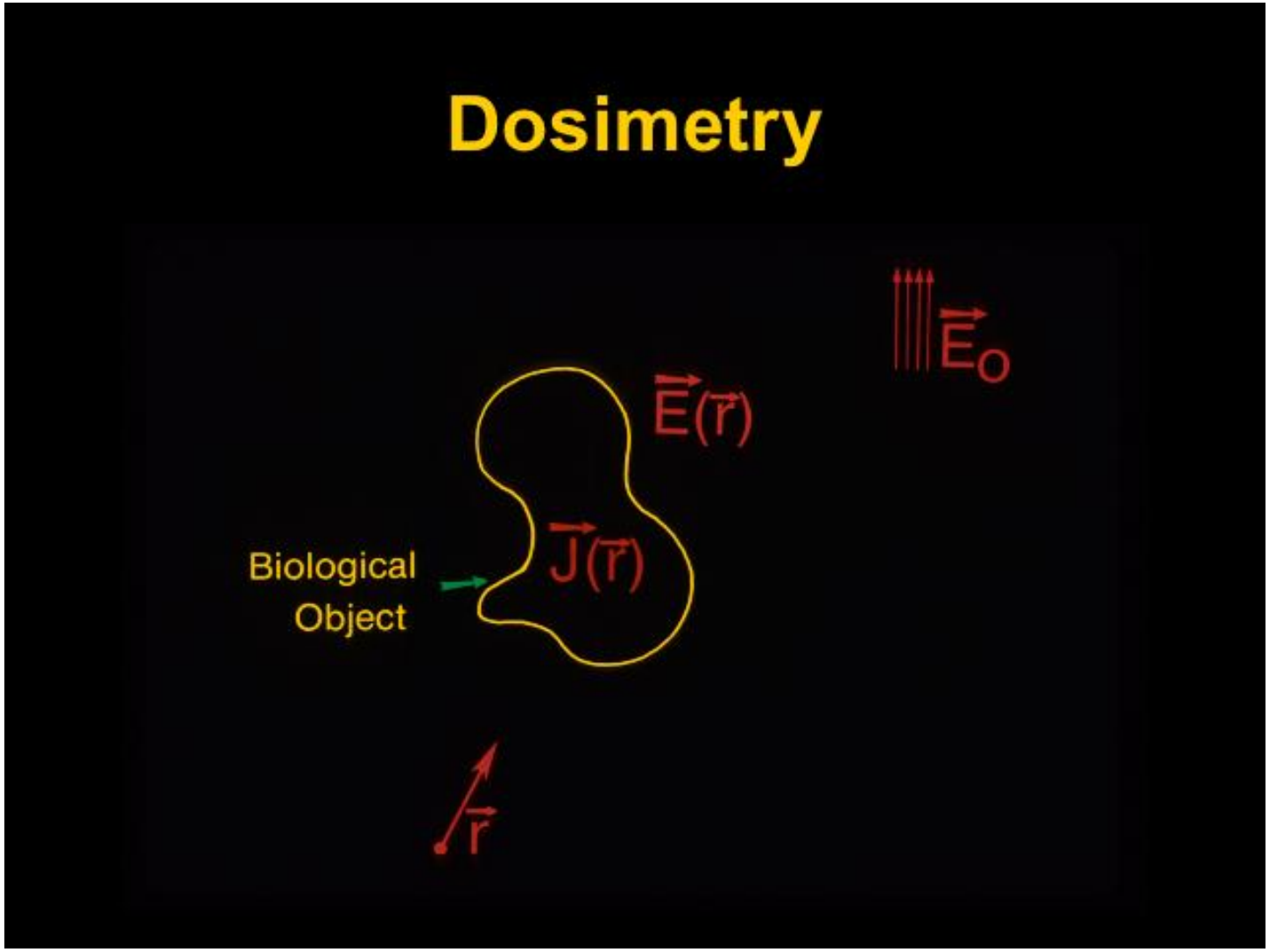
There is another aspect of the way Battelle's animal housing conditions jeopardized the data. The Battelle investigators used metal screening as the floor in their animal housing units. The floor was electrically grounded and, given the anatomy of male rodents, was in frequent contact with their testes. In the rodents that were exposed to the EMF this combination of male rodent anatomy and grounded flooring resulted in the passage of an electrical current through the testes of the rats and mice. The current was too small to be perceived by the animals, but the situation produced two fundamental problems. First, any changes observed in the exposed animals could have been due to the electrical currents, rather than the EMF. If that were true, then the results of the study would have been irrelevant with regard to health risks of powerlines because the passage of electrical current through testes is not a problem there. Second, the cage design clearly affects male and female rats differently, thereby greatly complicating evaluation of the implications of the results for human beings.



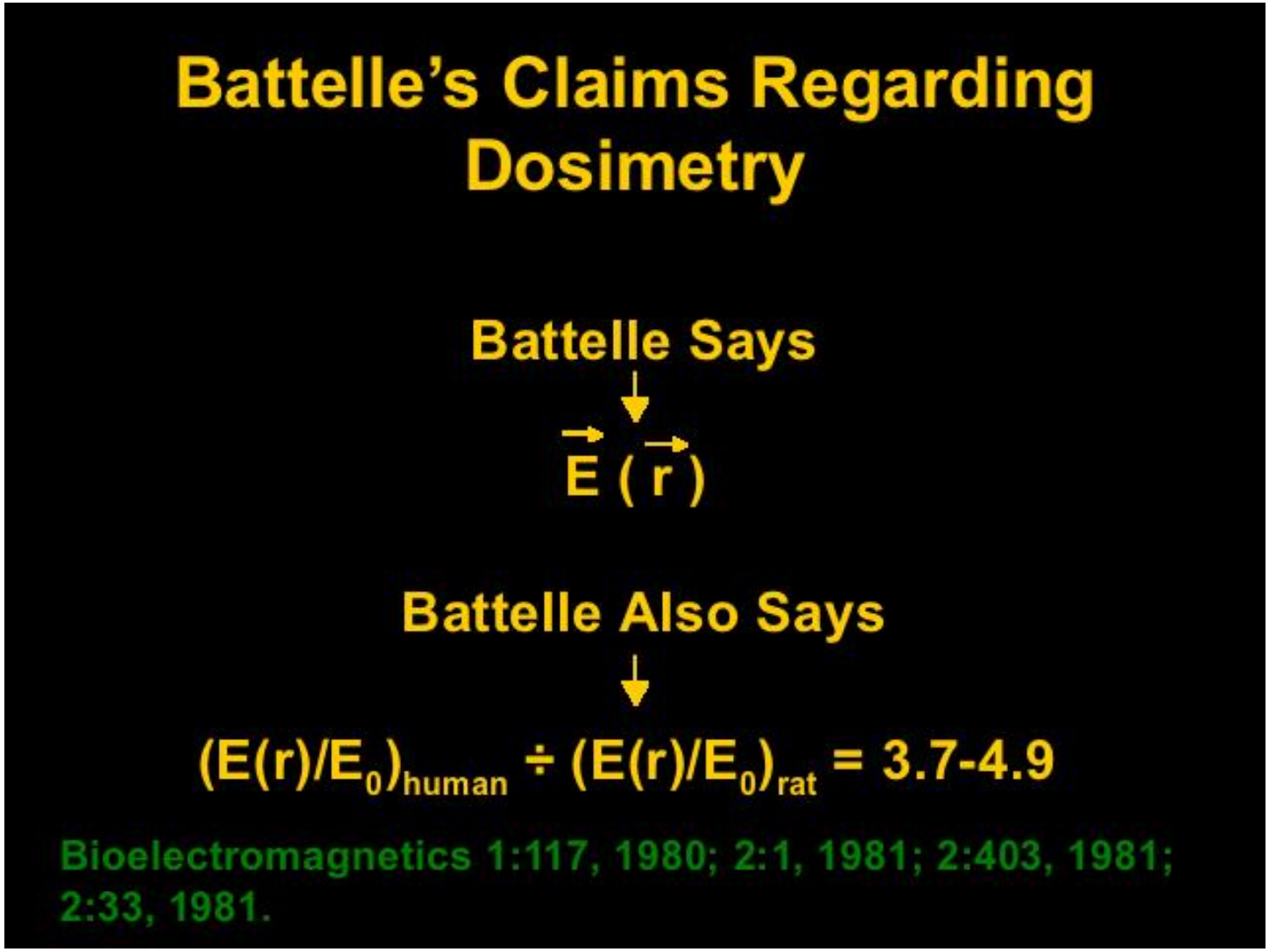
Is there any evidence that the electrical current that passed through the testes of the male rats produced any effects on the testes? Battelle investigators found that testosterone, which is manufactured in the testes, was consistently reduced in animals that were exposed to an EMF for 120 days.



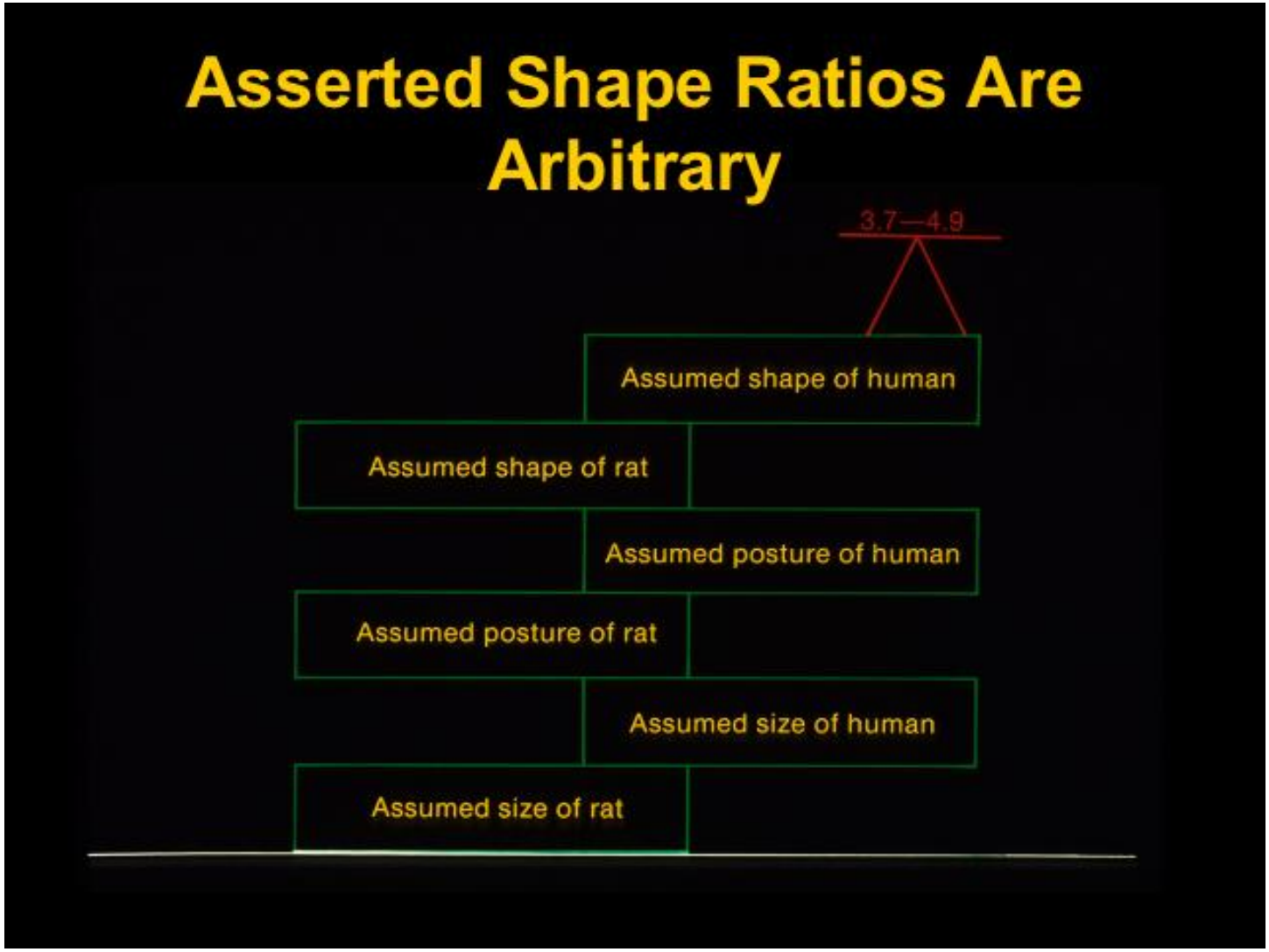
It can be seen, therefore, that Battelle employed a bad animal model. The housing conditions violated federal guidelines and resulted in animals that were chronically stressed and therefore useless for assessing the effects of EMFs. Further, the model discriminated between males and females in the sense that the method of housing rather than the EMF could produce different effects depending on gender. Finally, the model was seriously defective for breeding experiments because the grounded metal floor completely prevented the normal nesting behavior of rats and mice during and immediately after birth of the young.



I would now like to discuss the issue of dosimetry, by which I mean how that amount of exposure in the animal experiments should be related to the amount of exposure experienced by human beings along the right-of-way of high-voltage powerlines. Following the approach of the Battelle investigators, let us consider three quantities, **E**o, the electric field applied to an animal (determined as the voltage applied to a pair of parallel plates divided by the distance between them); **E(r)**, the electric field in the vicinity of the animal (which is imagined by the Battelle investigators to be materially different than **E**o); and **J(r)**, the current density inside the animal.



Battelle investigators claim that even though **E(r)** can't be reliably measured, it can be calculated. They say that they have performed these calculations and have shown that human beings distort the applied EMF 3.7–4.9 times as much as rats. Consequently, they claim, in order to evaluate the effect of an EMF on human beings, one must consider the effects of an EMF about 5 times stronger in animal studies, if the test animal is a rat.



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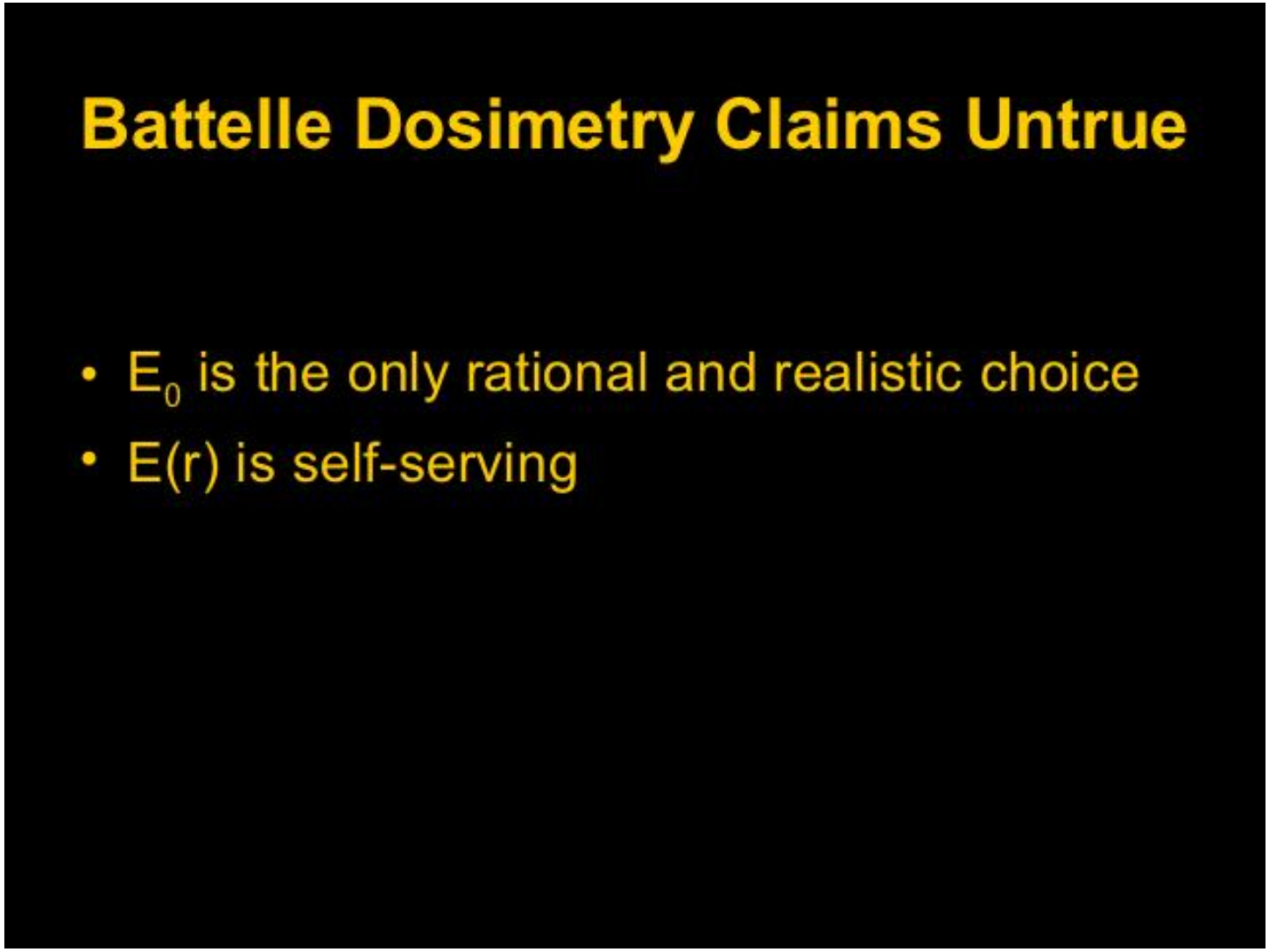
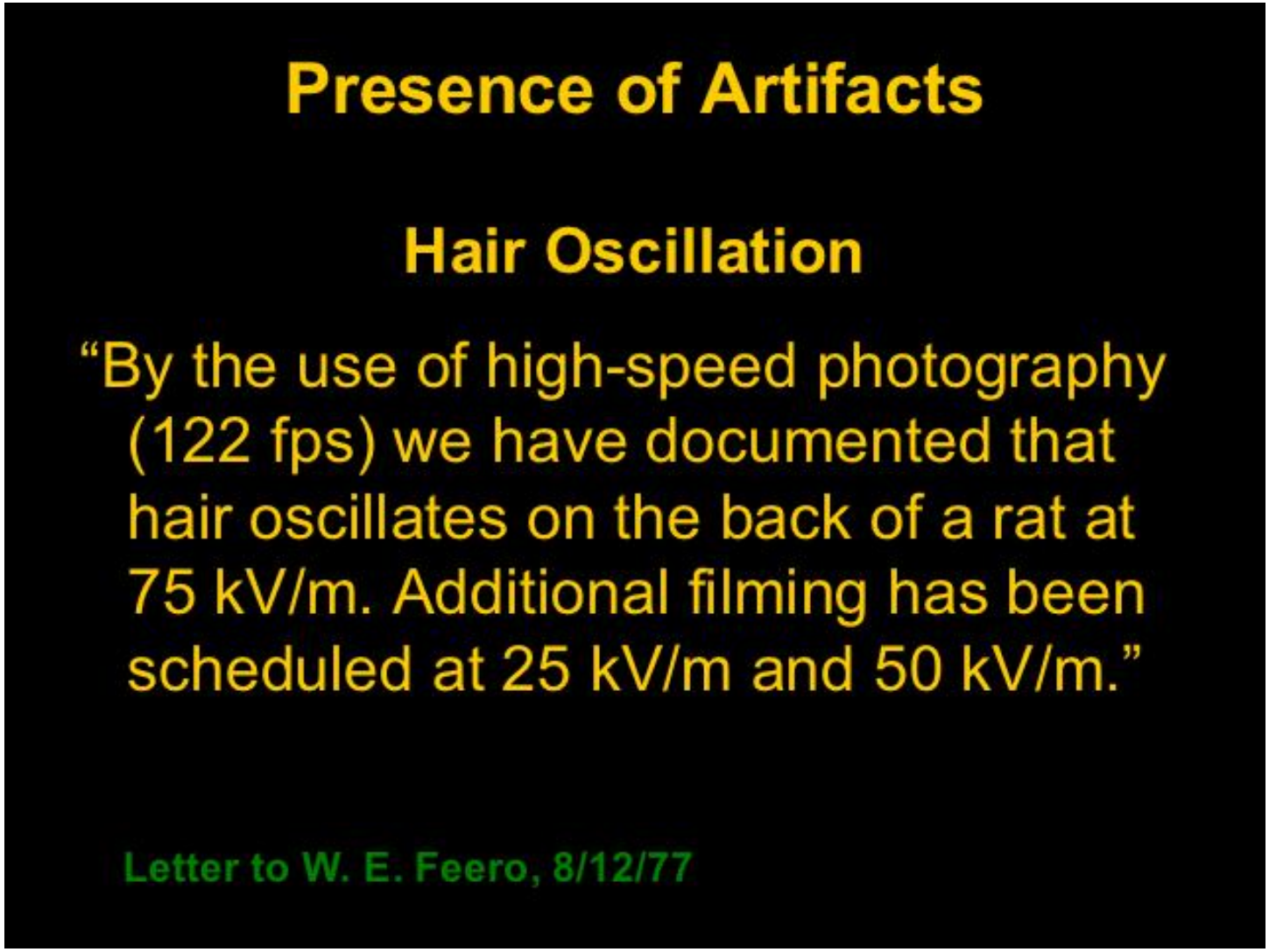


It seems to me, therefore, that Battelle's claim that it can calculate a meaningful value for **E(r)** is self-serving in the sense that it tends to enhance the perception of the precision and reliability of their work, particularly so I think among scientists who are not well versed in the intimate details of the politics and economics of the powerline EMF health-risk dispute. The truth is that **E**0, the applied EMF is the only rational choice for comparing experiments involving different animals and for evaluating their implications for human health risks, based on the present state of our knowledge.



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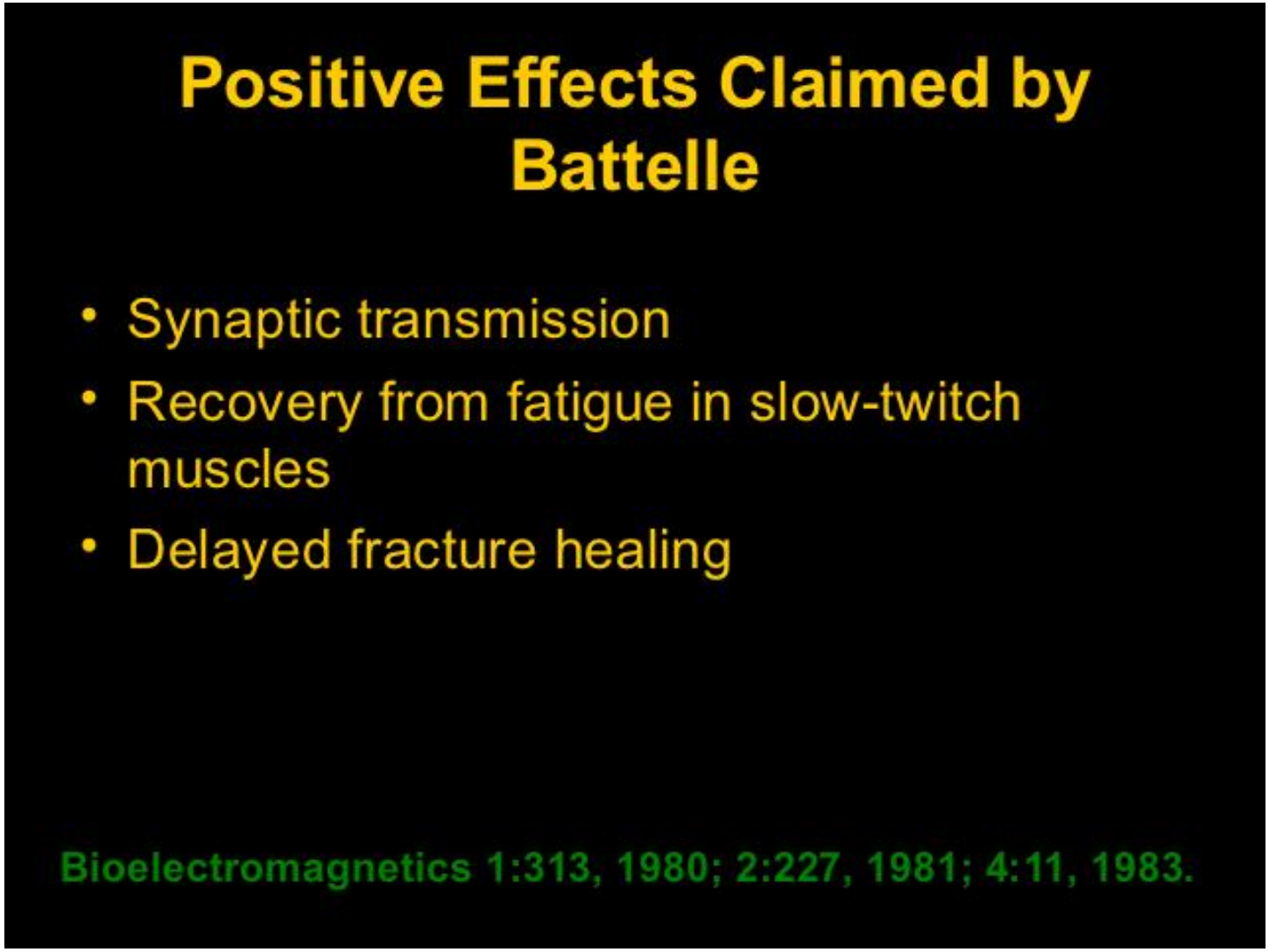
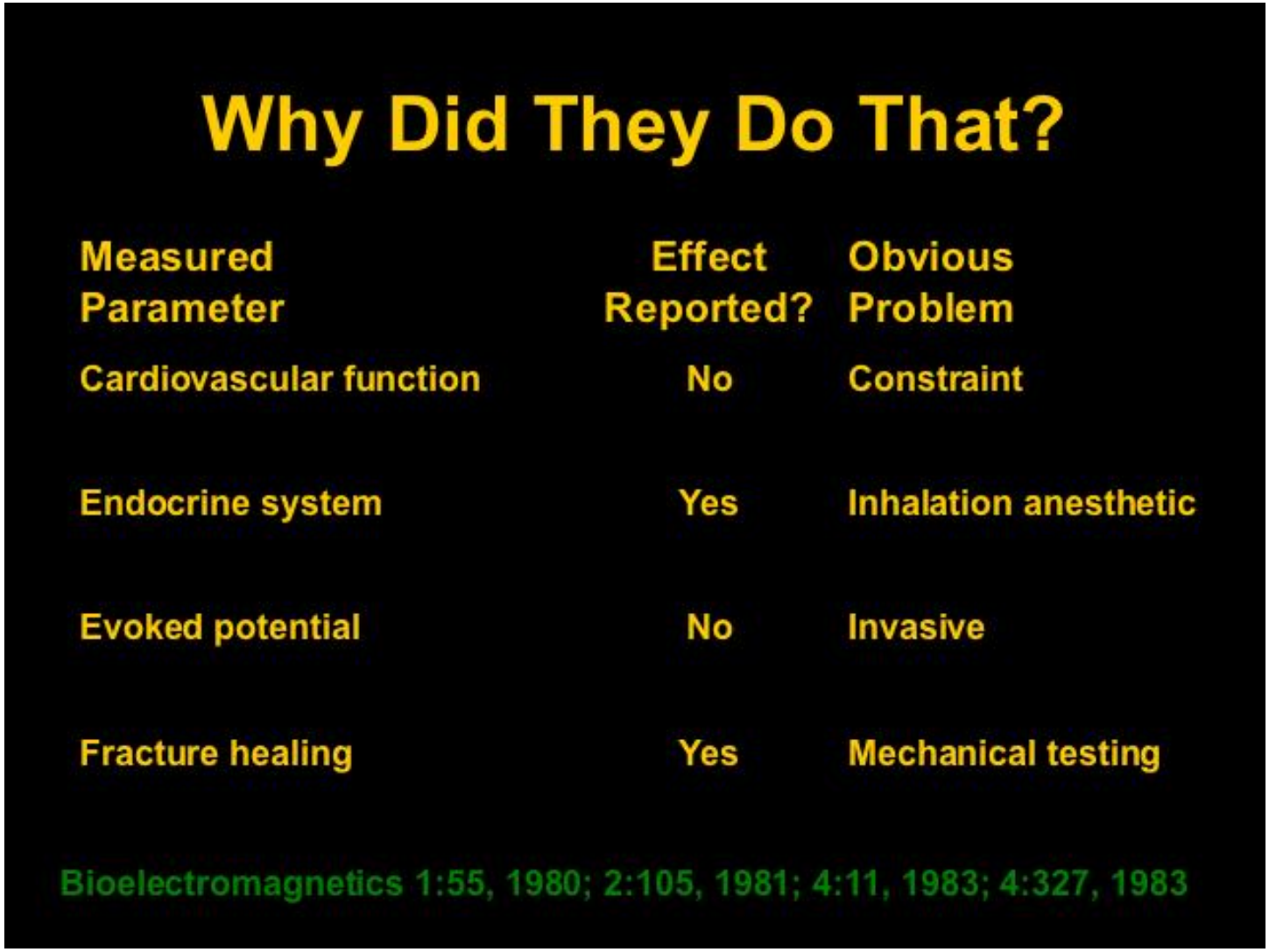


Although the Battelle studies have been mostly negative, the Battelle investigators did claim to find some positive effects due to EMF exposure. But because these effects were observed in animals that were being continuously stimulated by hair vibration it is impossible to decide whether the effects were directly due to the EMF, or were indirectly caused as a result of the response to the continual irritation of hair vibration. Consequently, even the positive studies done at Battelle have dubious value with regard to evaluating human health hazards from powerline EMFs, because human beings are not entirely covered by hair.

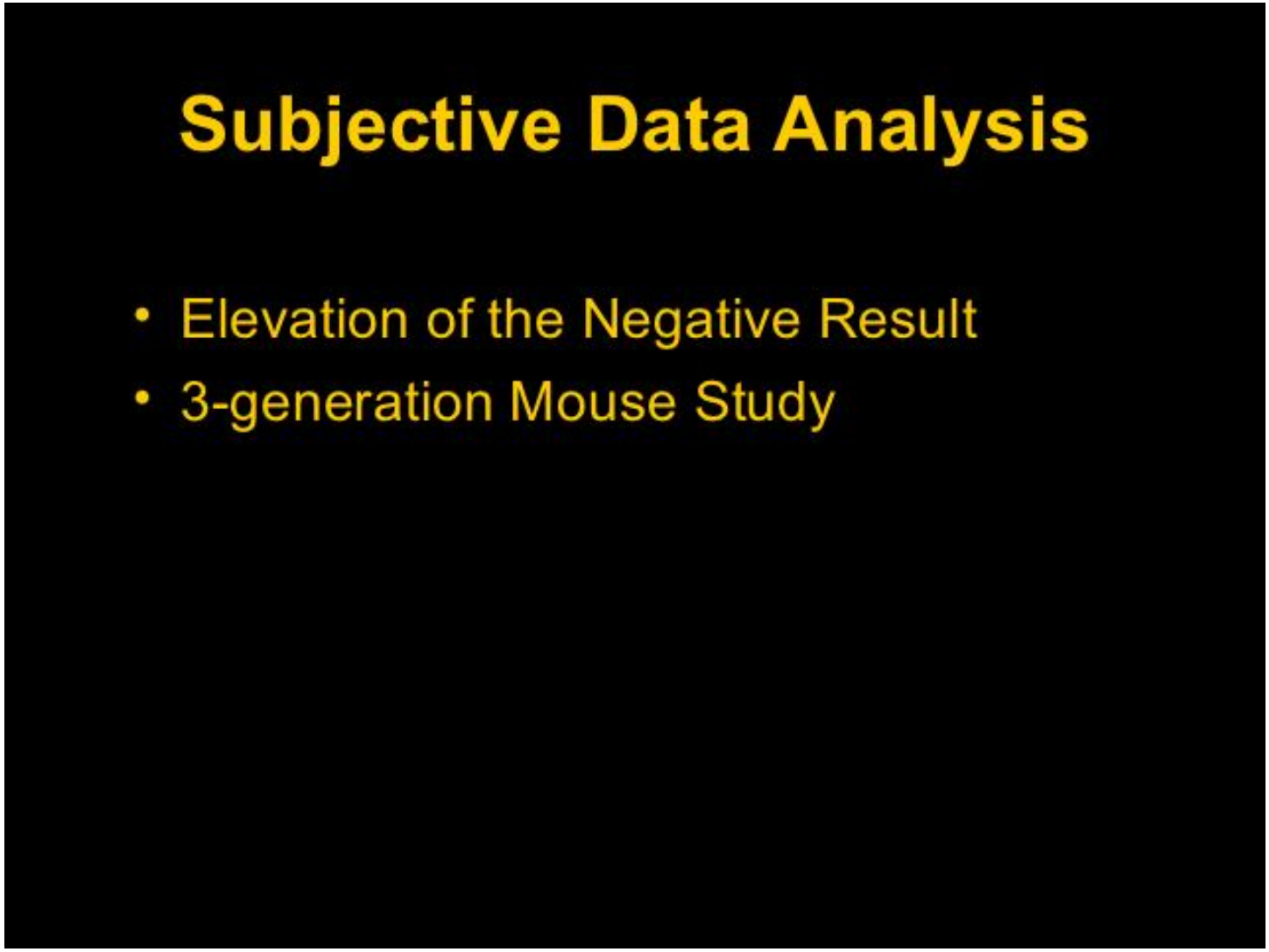
Why Did They Do That?

Measured Parameter	Effect Reported?	Obvious Problem
Cardiovascular function	No	Constraint
Endocrine system	Yes	Inhalation anesthetic
Evoked potential	No	Invasive
Fracture healing	Yes	Mechanical testing

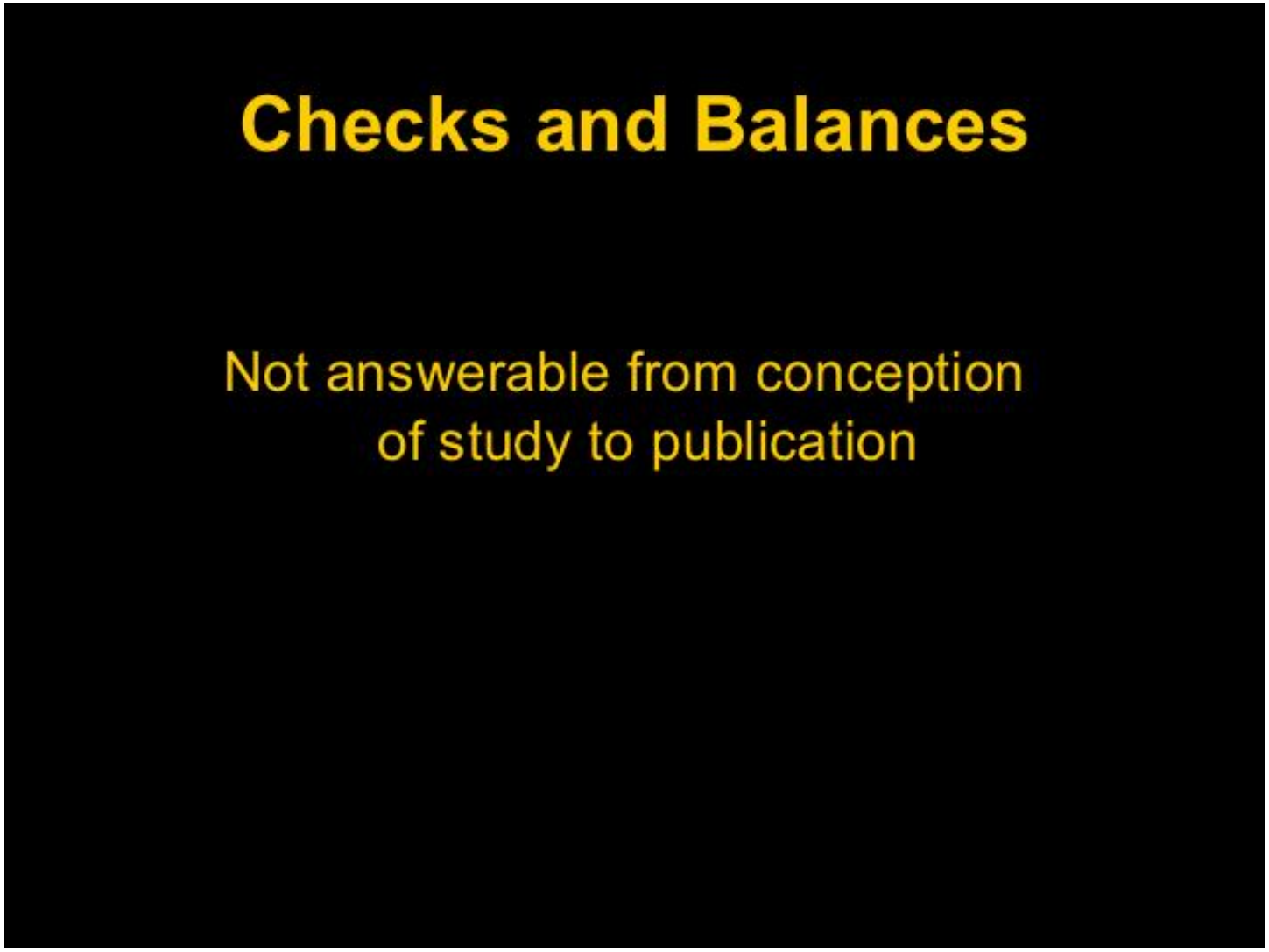
Bioelectromagnetics 1:55, 1980; 2:105, 1981; 4:11, 1983; 4:327, 1983



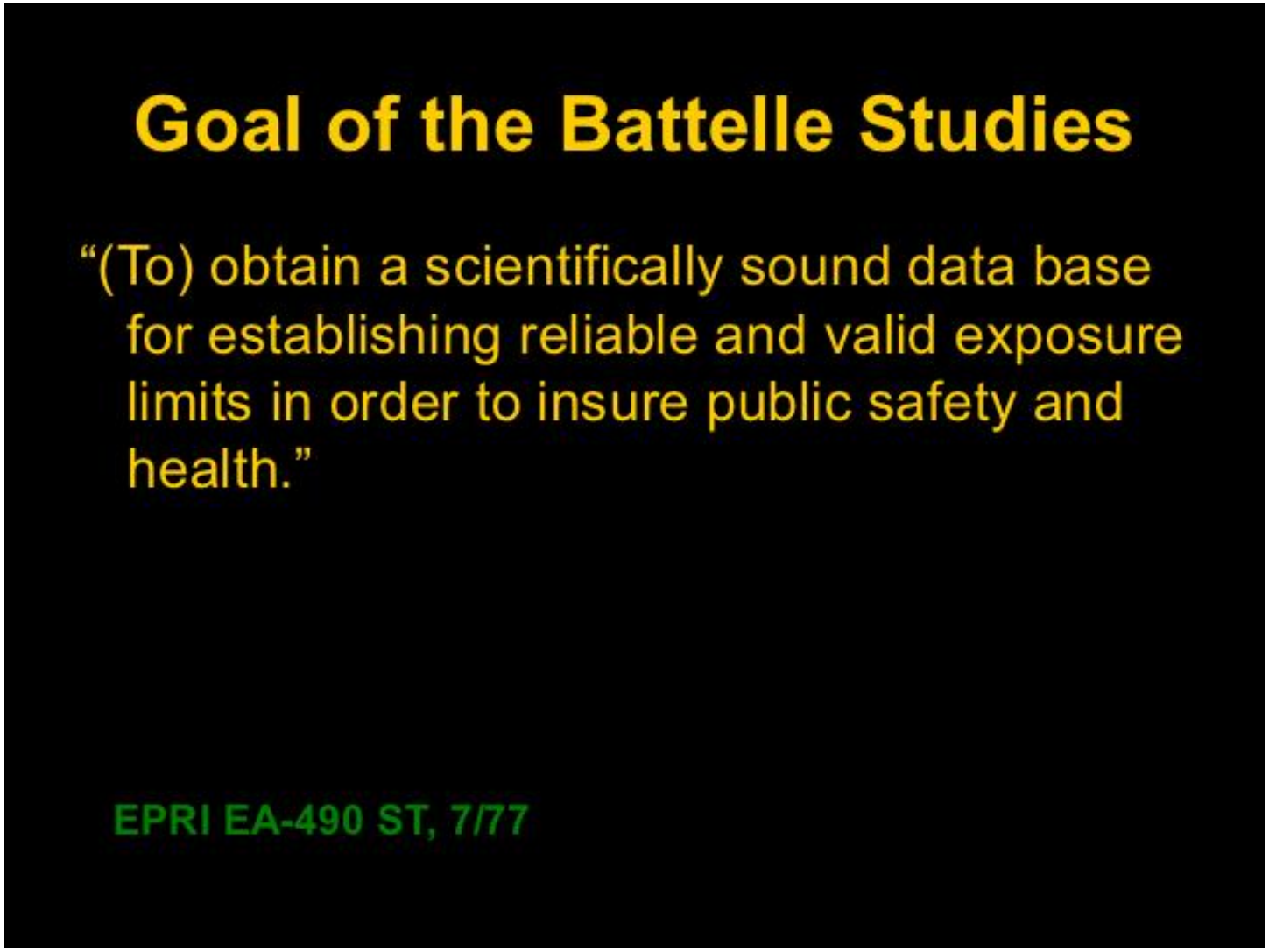
The details regarding how the Battelle investigators performed particular experiments reveal major shortcomings that simply destroy their value for most purposes, especially for evaluating human health risks. For example, in a study of cardiovascular function they measured heart rate under conditions that almost certainly affected heart rate, thereby obscuring any potential effect due to the EMF. In a study involving effects of the EMF on the endocrine system, they killed the animals using an inhalation anesthetic, which almost certainly affected the values of the endocrine parameters that were being measured in relationship to EMF exposure. In a study in which evoked potentials were measured, the Battelle investigators used invasive electrodes, something that is never done when the technique is used to study the nervous system in human beings. In a study involving fracture healing, the Battelle investigators chose a hopelessly insensitive method of evaluating the effect of the EMFs.



The Battelle investigators can also be faulted in the way they analyzed their data. The bulk of their work has been negative, and at this meeting as well as many previous meetings they have interpreted these negative results to suggest that powerline EMFs do not give rise to health hazards. But this conclusion is wishful thinking, not valid analysis, because most of the studies should have been negative in view of the conditions under which they were performed. Even studies that were actually positive were made to be negative by virtue of the way the data was analyzed. For example, in a study involving the exposure of mice to EMFs that was repeated twice, the Battelle investigators found statistically significant effects in both cases, but in opposite directions relative to the corresponding controls. What they did was average the results and claim that no effect was found.

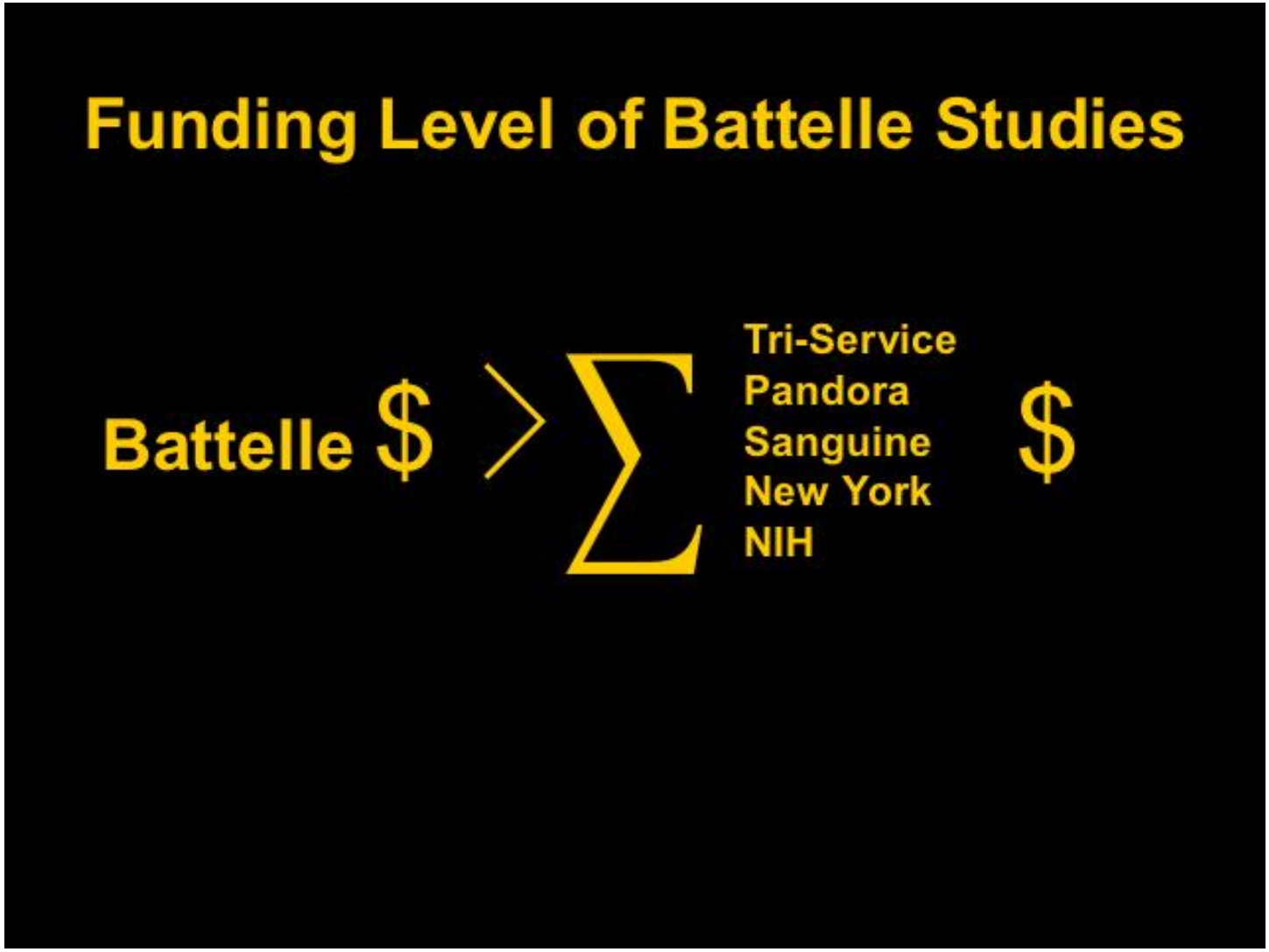


How did all of these shortcomings in the Battelle studies come about? The Battelle investigators had to satisfy their study sponsors, not a panel of their scientific peers, regarding the study design and conduct. Additionally, the Battelle studies were intended, from the beginning, to be done in secret and only partially disclosed. I think these were the main reasons.

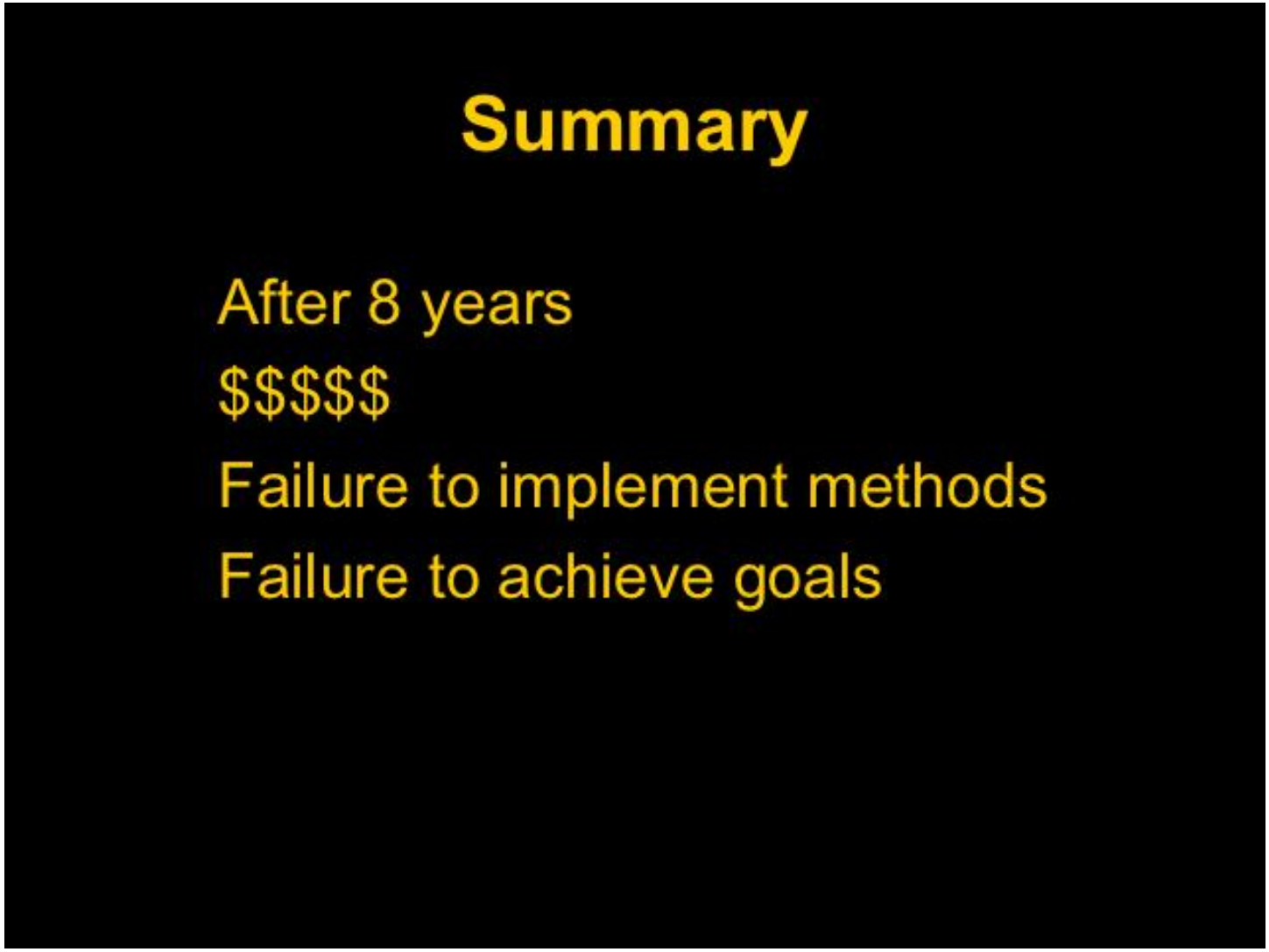


In summary, the explicit goal of the Battelle studies was to evaluate the health risks of powerline EMFs.

To accomplish this, the Battelle investigators held themselves out as experts who could design and conduct experiments that eliminated defects that they perceived in the studies of other scientists which led some to claim that powerline EMFs were health risks.



The Battelle studies were supported by prodigious sums of money from the power industry. Battelle probably spent more money for its EMF research than was spent to perform all other previous EMF studies, combined.



After many years and many dollars, the Battelle investigators have failed to conduct reliable experiments and failed to achieve their goal of providing a data base to evaluate powerline EMF health risks.