Supplemental Report of Frank Martin, Ph.D., July 10, 2007

1. Reinemann, Dairy Cow Response to Electrical Environment: A Summary of Research Conducted at the University of Wisconsin-Madison, part of Stray Voltage and Dairy Farms, a Conference for Farm Advisors, Educators, Utilities, and Public Policy Advisors, Camp Hill, PA., April 9-11, 2003. It is not clear if the conclusions were based upon the same data as reported in the 1999 Reinemann research listed below (Part III of Final Report). The study was conducted with 12 mid-lactation dairy cows subjected to intermittent electrical currents (stated to be "about 1 mA of current") for 14 days. This was compared to 12 cows with no treatment. Professor Reinemann makes some surprising statements regarding IgA, IL1 and IL2 (page 77). The data has not been produced, but may not be the same data as reported in the Part III of the Final Report. There were findings made on this experiment that showed (a) statistically significant increase in IgA (P=0.015), and (b) indications of an inversion of IL1 (increasing) and IL 2 (decreasing) across the treated group as compared to the non-treated group, which I am reliably informed are important factors regarding animal health. These findings support the conclusion that immune response can be changed by exposure to electric current and require more research to further define the specific responses in relation to IL1 and IL2. The statement in the paper that "these effects were not large enough to suggest major alterations in immune function by electrical currents" is disingenuous. Instead, additional research is indicated based upon the data reported. The statement made on page 75 that "the vast majority of cows will not perceive currents of this level" appears to be contrary to Dalziel's perception study in 1950. The statement on page 75 that "In order for current exposure to affect cows, the applied current must be of sufficient level to cause avoidance behavior" is not supported in any cited literature and I have not seen any literature which supports this statement.
2. Reinemann, et al. 1999. Dairy Cow Response to Electrical Environment Final Report – Part III. Immune Function Response to Low-Level Electrical Current Exposure. The coefficient of variation (CV) in this study is very high, approximately 125%. The conclusion reached that there is no effect from low level electrical current is unsupportable from the data reported. The number of cows is too small and would have to be in the hundreds of animals to demonstrate a practically important effect. However, there is a huge response difference between treated and non-treated cows in terms of staph aureus. In addition, there is an effect on IL1, and a small change in IL2. This interleukin information is consistent with the effects reported on interleukin in Dairy Cow Response to Electrical Environment: A Summary of Research Conducted at the University of Wisconsin-Madison, part of Stray Voltage and Dairy Farms, a Conference for Farm Advisors, Educators, Utilities, and Public Policy Advisors, Camp Hill, PA., April 9-11, 2003 and supports the need for a much larger study in terms of cows and exposure times investigating these factors.
3. Reinemann, et al. 1999. Dairy Cow Response to Electrical Environment Final Report – Part I. Comparison of Behavioral to Physiological Responses. Figure 6 shows a cortisol response increasing with increasing current. A weak statistical

analysis presented by the authors fails to observe it ("none of the averages were statistically different from zero"). A proper statistical analysis would have observed a significant correlation between cortisol response and current dose. Either the authors were statistically ignorant or were intellectually dishonest.

4. Dalziel and Mansfield. Effect of Frequency on Perception Currents, AIEE Transactions, 1950 Vol. 69, pp. 1162-1168. In figure 2, the distribution of perception thresholds is presented for 60 cycle current in humans. The $10^{th}$ percentile is .75 mA and the $50^{th}$ percentile is 1.1 mA. There is large volume of literature that concludes that dairy cows are more sensitive than humans.
5. Anashansley and Gorewit, 1992 Journal of Dairy Science 75:2733-2741, Cow Sensitivity to Electricity During Milking. This was a study using 8 cows where current was applied through the milker to the teat. On Table 1, it was reported that 16 volts produced no effect. The number of milkings is not reported on trial 1 for each voltage level. This is a surprising result based upon other known literature. Based upon the data reported, it is hard to rely upon the conclusion.
6. Anashansley, et al., Aversive Response of Dairy Cows to Voltage/Currents on Waterers at Frequencies of 60 Hz and Above, ASAE 97-3109, meeting presentation at Minneapolis Convention Center, August 10-14, 1997. Definitions were given for transients ($\leq 1/60^{th}$ sec.), momentaries (between $1/60^{th}$ and 1 sec.) and steady state ($\geq 1$ sec.). Cows were selected from the Cornell herd that were producing more than 60/lbs. per day. This establishes that the Cornell herd had cows that were capable of producing 60/lbs per day (18,300 per year using 305 day lactation) and is to be compared to the cows used in the 1992 Gorewit research where one treatment group had a RHA of 6,900 kg (15,180#) prior to inclusion in the study.
7. Henke-Drenkard, et al., Milk Production, Health, Behavior, and Endocrine Responses of Cows Exposed to Electrical Current During Milking, 1985 J. Dairy Sci. 68:2694-2702. This was a small study using 6 cows with current applied during milking. Cortisol concentrations were rising over all time periods and were affected by 8 mA current as shown in table 2. These results are statistically significant – cortisol is affected by current. The authors agree with this conclusion (page 2701). The authors state that cow resistances are lower than humans and that "[t]he low resistance of cows as compared to humans explains the greater sensitivity of cows to low voltages." Page 2697. The authors also state that: "It is extremely difficult, if not impossible, to duplicate 'stray voltage' conditions occurring on the farm in a laboratory environment." Page 2701. This observation highlights the importance of field studies in stray voltage research. The fact that a statistically significant elevated cortisol response to current can be observed with only a 6 cow study invites a larger study at lower currents with more cows. One of the six cows exhibited unusual avoidance behavior similar to that observed in field reports in reaction to anticipated current. Page 2697.
8. Lefcourt and Akers, Endocrine Responses of Cows Exposed to Controlled Voltages During Milking, 1982 J. Dairy Sci 65: 2125-2130. This is a study based upon 6 healthy early or mid-lactation Holstein cows from the Beltsville herd. This study is important in that milk yield and milking time decreased in response to intermittent voltage stimulation (but not in response to continuous voltage

stimulation) at approximately 1.1 to 1.6 volts, which, he author states "barely exceeded proposed recommendations for acceptable neutral to ground voltages." Page 2128. There was also a strong prolactin response to intermittent stimulus as seen in figure 3. The author states that: "The electrical resistance of cows is .1 to .5 times of humans. This difference in resistance results in a proportionately greater body current in cows as compared to humans subjected to a given voltage differential." Page 2125. This strong prolactin and milk response again demonstrates the need for field studies where the exposures to the electrical stimuli are not being controlled.

9. Lefcourt, et al., Effects of Intermittent Electrical Shock on Responses Related to Milk Ejection, 1985 J. Dairy Sci 68:391-401. Thirteen cows were subjected to intermittent electrical shock at am and pm milkings for 7 days on a strictly repeated and completely predictable regimen. The shocks were controlled in that there were 5 s. on and 25 s. off. Seven cows were in the 3.6 mA group and 6 cows in the 6.0 mA group (one of the cows would not be milked because of severe behavioral responses to shock). The authors conclude: "We think that milk yield can be maintained, at least in the short term, in cows subjected to electrical shock due to power-line problems if dairy producers take exceptional care to accommodate behavioral responses." Page 391. "Cows are susceptible to electrical shock because their electrical resistance is low, less than one-tenth that of human electrical resistance." Id. The cows had violent initial reactions but were trained to tolerate the treatment, with one exception noted. Behavioral responses were gross and exaggerated and some of the shocked cows could not have been milked without individual attention, a luxury the normal dairy farmer may not have or may not tolerate. This study did not observe the strong prolactin response noted in item 8 above. This again highlights the problems with predictability in controlled experiments and highlights the need for field studies. The study acknowledges violent first reactions, but does not offer information or understanding of shock effects where stimuli are uncontrolled and chronic as is the case in the field.
10. Reinemann and Stetson, Effects of Frequency and Duration on the Sensitivity of Dairy Cows to Transient Voltages, ASAE 943597, presentation to ASAE, Atlanta GA, December 13-16, 1994. The analysis presented in table 2 in most part is a frivolous use of statistical significance testing. For example, it tests the obvious false hypothesis that all cows behave the same way and comes to obvious conclusion that they don't. The study generally concludes that at very high frequencies, cows require higher current to elicit a physically observable reaction. No conclusions are reached regarding effects of chronic, uncontrolled exposure to such higher frequencies.