

April 30, 2009

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Kirsten Walli
Board Secretary
Ontario Energy Board
P.O. Box 2319
2300 Yonge Street
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To: The Ontario Energy Board

Re: File Number EB-2007-0709

The following is pertaining to the current proposal under Section 70.2 of the Ontario Energy Board Act, 1998 to amend the Distribution System Code pertaining to Farm Stray Voltage. The comments below pertain specifically to the Board's intention to prescribe an investigation procedure as part of Appendix H of the Code, which will permit the accurate determination of the contribution from the distribution system to total measured farm stray voltage at animal contact points.

These comments will refer to the equipment to be used as noted in section H.3.3 – including a five hundred Ohm shunt resistor or equivalent combination of resistors - and the Investigation Procedure in Section H.5 pertaining to the voltage data to be recorded across a five hundred Ohm resistor as part of the Farm Stray Voltage Test in Section H.5.1.2. Comments will also about whether a shunt resistor should be needed even at all.

Dr. Don Hillman, Ph.D, Professor Emeritus, Department of Animal Science, Michigan State University, Dairy Consultant donag1@aol.com

The following is regarding inclusion of Electric and Magnetic Fields (EMF) and relative animal resistance in measurement of Stray Voltage on Dairy and other Livestock farms.

Please reflect that Ontario Hydro and Hydro One Networks have known about harmonic interference from equipment connected to the power system and produced a Guide in 1975 for handling such interferences based on corporate experience and testing prior to 1975. The Guide has been updated and reproduced under various titles periodically ever since. Unfortunately, affected customers were not privileged to knowledge of such information unless equipment on their farm was determined to be the cause of such harmonic interference. Information about utility equipment and electronic devices producing such interference was never disclosed. However, it is now recognized that harmonic disturbances or noise produced at one customer's electrical service can influence all customers bonded to the same distribution neutral to earth circuit as well as phase harmonic disturbance.

The demonstrated fact that animal impedance decreases as frequency of the interfering voltage increases requires adjustments for frequencies other than 60 Hertz (the fundamental frequency if voltage is the only measurement taken). Most commonly used voltmeters will not measure frequency; therefore a reading by a reliable ammeter would be the best indication of electrical current, the flow of electrons through an animal that interferes with electrochemical processes within the animal.

The influence of voltage frequency on impedance of pigs was demonstrated by Hydro at the University of Montreal, Lennoxville, Quebec (1992). Unfortunately, the effect of 10,000 Hz frequency on performance of pigs was not tested in these experiments.

The effect of 60 Hz to 100,000 Hz frequency on impedance of dairy cattle was investigated by Aneshansley et al. (1995 and 1990) at Cornell University. They reported that impedance decreased as frequency increased and corresponding current flowing through the animal increased.

Similarly, Wisconsin workers investigated the source of impedance of 101 stalls in 43 dairy barns and reported the average resistance for cows with all feet on the floor was 150.084 Ohms and the median resistance was 115.472 Ohms. The standard deviation was 97.9 Ohms. As you know one standard deviation accounts for two-thirds (66.67%) of the observation, and two-standard deviations account for 95% of the observations in a normally distributed population.

Since frequency has been shown to be an independent variable influencing impedance of cattle, a simple table of impedances for various harmonic or radio frequency currents could be prepared for estimating current from voltages at various frequencies (Mark Cook of the WI PSC and Dr. Douglas Reinemann were among several coauthors of ASAE paper Number 943601).

Because the permeability of biological tissue (man and animals) is about the same as air, a simple meter for measuring current would solve the problem and avoid confusion from estimating voltage without knowledge of the frequency as now occurs.

Utilities, and the Courts, decide the fate of plaintiffs and defendants based on conclusion of the current to which the animals, and perhaps the owners or caretakers, were subjected. Failure to consider the full impact of a high frequency current would be unscientific and unjust.

The objective for all parties ought to be to reduce the interference to minimal levels. Even 1 milliAmpere interfered with normal adrenal hormone and immunological responses as presented by Dr. Reinemann to the *Minnesota Public Utilities Commission* (1998) and to the *Stray Voltage on Dairy Farms Conference* in Pennsylvania (2003).

The Premises leading to the following conclusions are as follows:

1. Very small amounts of electricity affect dairy cows--1 milliampere of current, front to rear feet for 2-weeks, causes changes in blood concentrations of adrenal hormones, immunoglobulins, and Interleukins 1, 2, and 10, which regulate the lymphocyte defenses of the animal, according to reports by Douglas Reinneman, Sheffield, et al. (Report to Minnesota PUC, 1998; Stray Voltage Conf, 2003). Claims that five milliamperes affect cattle are certainly correct but are not the threshold level.
2. Milk production decreased in proportion to harmonics in step-potential voltage in milking stalls.

3. Creatine phospho-kinase, an enzyme responsible for transfer of energy from creatine > (cyclic) cAMP>cADP> cATP across cell membranes is significantly different in the blood of pigs exposed to 2-V and 5-Volts compared to 0-Volts reported in investigations of “*The Effects of Stray Voltage on the Performance, Behavior and Health of Fattening Pigs– Stage 1*.” (This was the finding at the University of Montreal, Quebec, and Canadian Electrical Association, 1992). This is a very important finding that was also reported in neutraphyls of humans (Variani et al., 2002).

Recommendations:

1. Require that electrical measurements regarding complaints of producers be made with a Power Quality Meter, e.g. Oscilloscope, Drantz Power Analyzer, or other instrument that will measure voltage, frequency and current at cow contact locations, which include step potential in barns and milking stalls.

2. In such cases where frequencies of voltage have been recorded with an appropriate instrument, current will be estimated according to the observations of Aneshansley et al., **Holstein Cow Impedance From Muzzle to Front, Rear, and All Hooves.**, ASAE Paper No. 953621 (1994).

3. If because of circumstances only voltmeter measurements are obtained, a 500-Ohm resistor shall not be included in the test circuit; rather, resistances described in the article: *Effects of Source Resistance on Cow Contact Voltage Measurements*. ASAE Paper 943601, by Mark A. Cook, Daniel M. Dasho, Richard Reines, William E. Dick, Douglas J. Reinemann, John Ryder, and David F. Winter shall be applied for estimation of current at the voltage recorded.

Failure to update the standards in terms of the most recent information available will undoubtedly require revision shortly.

R. Lee Montgomery, Doverholm Farm, RR#1, Dover Centre ON - 519-352-8192 – former dairy producer liquidated due to Farm Stray Voltage

I feel a 500 Ohm shunt resistor is in the interest of the utility only. That level is way too high and allows the utility too often to say there is nothing at source or certainly below whatever threshold it may be using. The actual reading on either a voltmeter or ammeter is really what a cow actually feels. One can not make a cow out of a copper plate nor out of a shunt resistor!

Recommendation:

The level of the shunt resistor should be no more that 150 Ohms and preferably not more than 100 Ohms – not 500 Ohms. I still need to be convinced that a resistor needs to be used at all.

**Dr. Jim Morris - Former Head Animal Science Department, Ridgetown Campus,
University of Guelph – Dairy Cattle Consultant jrmorris@hotmail.com**

This is intended to add to the discussion on Shunt Resistors and using the paper by Cook et. al.(1994) for backup information.

The question about shunt resistors being present to measure the voltage in transient voltage cases needs addressing. It seems to me that the attempt to measure the voltage with a resistor in the meter to be used is to give some indication of the current through the cow. The question to be asked is why is there any need for this?

If the shunt is present then the estimates of current going through the cow is affected by the level of the resistor. Not being an electrical person but one who examines the effects of current on cattle it would seem logical to measure the voltage present at the specific contact points that might represent the voltage affecting the cow whether it be nose either front foot, nose to either hind foot, etc. With these measurements one would apply the appropriate level of resistance of the cow to calculate the current. Let us remember that it is the current/energy flowing through the cow that causes the actual damage. The following table was taken from Cook et al. (1994) and modified to show actual amps through the animal with 1 V.

Table from Cook
et al.- (1994)

%OF COWS	COW R(OHMS)	MIN MAMPS
90	525	1.56
50	361	2.10
10	244	2.78

Looking at the resistance of cows we see that 90% of the cows exhibited 525 Ohms of resistance. A cow with this resistance is having 1.56ma minimum passing through the body. These levels are actually lower than the actual levels calculated by using $Mamps = (I/R)/1000$. Fifty percent of the cows exhibited a resistance of 361 Ohms indicating 2.10 ma minimum current passing through the body. Furthermore, 10 % exhibits a resistance of 244. In this case the cow exposed to 1 volt would have a minimum current as calculated of 2.78 amps. My concern is with 10 percent of the cows having 2.78 amps flowing through the body. If this is this case then the 1ma acceptable level is much higher for these cows.

In any herd if 10% of the herd is negatively impacted by the transient currents, it is my experience that this would start the herd on a downward spiral in production, reproduction and economic performance leading to the demise of the farm if it cannot be corrected. It is my opinion that voltage readings are not a good indication of current impacting on the cattle.

Recommendations:

We need readings of actual current. Furthermore, I need to be convinced that a shunt resistor is even necessary at all!

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