Wisconsin Farmers Union
UNITED TO GROW FAMILY AGRICULTURE

Memorandum: Proposed Stray Voltage legislation
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Recently, Representative Honadel and Senator Farrow circulated a bill (LRB 1956) that would limit utility liability for damage caused by stray voltage. According to the bill, an electrical cooperative or publically-owned utility would not be liable for any stray voltage damage if it can prove that "the electric facilities owned or operated by the electric service provider and providing service to the location of alleged damage are operated and maintained in compliance with all engineering and safety standards adopted by rule or order by a state regulatory agency and applicable to the facilities."[1]

The state regulatory agency that governs utilities is the Wisconsin Public Service Commission (PSC). The Wisconsin PSC has previously established their "level of concern" at 2 milliamps (mA) of current.[2] When determining the "level of concern," the utility assumes the resistance of the cow to be 500 ohms. Under this assumption, the voltage at the level of concern then equals one volt.[3]

Wisconsin Farmers Unions is very concerned about the proposed bill for several reasons. First, WFU is concerned that the assumed level of resistance with this level of concern does not adequately protect all cows. Secondly, Wisconsin Farmers Union is concerned that method of testing recommended by the PSC does not adequately protect livestock from potentially harmful electric shock. Finally, this bill would leave farmers without any recourse whatsoever in almost all cases of "non-traditional" stray voltage or ground current, which have been recognized by Wisconsin's courts to cause harm to livestock and production loss to farmers.

Many Cows have Resistances Lower than PSC's Level

According to the PSC a 500 ohm resistance level for a cows resistance to current is a "conservative" point below where moderate avoidance behavior is likely to occur.[4] However, early studies on cow behavior to stray voltage contradict this conclusion.

Cows, like humans, have been found to have a wide range of resistance to electricity.[5] This is due to the fact that the resistances of a cow can differ depending not only because of differences in contact resistances (how the current gets through the cow) but also due to the cow's pathway resistance

[1] LRB 1956 895.63 (2)(a)
[2] PSC 05-EI-115 (1996). More specifically, the PSC level of concern is 2mA of current, AC, rms, steady state.
[3] This is when using Ohm's law, I=V/R, where I=current in amps, V=volts of electricity, and R= resistance in Ohms. Note that 1 mA is the equivalent of 1/1000th of an amp.
[4] http://psc.wi.gov/utilityInfo/electric/documents/strayVoltage/whpaper.pdf, see note 1.
[5] 1984 MN Dairy Update

(how the electricity travels through the cow).[6] These early studies focused primarily on the level of current it takes for a cow to perceive the current. One 1982 study by Alan Lefcourt focused on recognizing mild responses from a cow such as flinching or vocalizing and distinct responses like becoming startled or raising a leg.[7] The cows in his study showed a mild response at a voltages range of 0.199-1.12 volts and showed distinct responses at voltages from 0.272-1.49. The cows were measured to have a resistance of 250-405 ohms, all well below the PSC's so called "conservative" resistance level. Another Lefcourt study published the same year had one cow with a resistance as low as 219 ohms.

In 1984, The University of Minnesota Diary Extension published a Dairy Update in order to consolidate researchers' findings on stray voltage up to that time. What they concluded was that the averages of several cow pathway resistances ranged from 350-1700 ohms.[8] However, in a couple of these studies, the statistics for the most sensitive cows were thrown out of the findings, skewing the results. One researcher only included the 10th through the 90th percentiles of resistances in his study. Even though the resistance data from the most sensitive 10% of cows were not included in his study, he still showed cows with resistances as low as 244 ohms.[9]

Estimates of cow resistance are extremely important when measuring the amount of current that a cow is receiving, and are a major area of concern when it comes to limiting an electricity provider's liability for stray voltage. Ohm's law is used to calculate current. Ohms law is I=V/R. The letter I represents the amount of current measured in amps (1 mA is 1/100^{0th} of an amp), V is the voltage, and R is the resistance measured in ohms. The PSC's level of concern for a utility's contribution of stray voltage is 1 mA = 0.5 V/500 ohms. Any amount of current under 1 mA the utility is not liable for and does not have to mitigate. However, let's say that a lower amount of voltage, 0.45, is hitting a cow that happens to have only 219 Ohms of resistance. Using Ohms law, that means that this particular cow is being subject to 2.05 mA of electricity, or over twice the "level of concern" set by the PSC. Even if this cow were having behavior problems (such as avoiding feed and water) that are causing losses to the farmer, the utility would not be liable, since the PSC guideline assumes that all cows have 500 ohms of resistance. It is for the reason that Wisconsin Farmers Union does not believe that the PSC's level of concern adequately protects farms in the state and a utility's liability should not be determined by this number.

Recommended Testing Procedure Also Inadequate

In PSC Docket 106, the commission recommended using a voltmeter for measuring stray voltages. A voltmeter can measure voltage after it has been loaded with an input resistance. Since the PSC's level of concern uses 500 ohms as its "conservative" standard it is that level which serves as the

[6] 1984 MN Dairy Update
[7] 1982 J Dairy Science 65:672-674
[8] Nov 1984, University of MN Extension Dairy Update, Issue 70. See abstract
[9] *Id.* See table 1, p 21.

input resistance used while testing for stray voltage. You can than take those two figures and use Ohm's law to find the current. However, the PSC standard also specifies that the 2 mA level should be measured in "RMS, steady state." RMS, or root mean squared, essentially averages the voltages over the waveform, using a tool called an RMS voltmeter. Steady state is the value of an average over a one minute interval. An RMS voltmeter test result is the average of all wave forms of voltage that happen within a one minute interval.

While this type of testing is suitable for locating and documenting constant currents of voltage running through points of contact, stray voltages does not always behave in this manner. Transient voltage is stray voltage that is of high frequency or short duration. These frequencies commonly come from improperly installed electric fences and switching on electrical devices on a farm.[10] A common source of these short duration pulses is the starting of large electric motors, with pulses often only measured in milliseconds.[11] Taking these types of pulses into account when measuring with a voltmeter is problematic, because a short burst of high voltage can be diluted by averaging it. Say, for example, that a cow was hit with 1,000 volts for 1/1000th of a second over a cycle of one second. The voltmeter averages out that 1/1000th of a second of very high voltage with the other 999/1000^{ths} of second of no voltage, for an average of one volt. A cow that received a significant shock while drinking or eating at a particular location will likely avoid that spot long into the future, even though that spot only rarely has significant current running through it. This is exactly why using an RMS voltmeter does not always offer an accurate picture of how stray voltage is actually affecting a farming operation.

Additionally, the extent of testing performed by utilities begins and ends with using a voltmeter. This was never intended to be so, according to the PSC according to 1989's Docket 05-EI-106.

> "By describing these basic screening measurement tests, the Commission is not saying that further investigation is not warranted if the basic tests do not indicate a problem. There is no substitute for good judgment based upon an observation of the actual behavior of the animals and the consideration of other variables, including non-electrical factors. The Commission expects that additional efforts beyond the basic screening tests will be pursued when those observations justify such further action."[12]

Essentially, the PSC did not initially intend for the voltmeter to be the only method for the investigating utility to measure for stray voltage. Yet, in the *Hoffmann* case, as soon as the tester found the recorded voltage level to be below that of the PSC's "level of concern" they left and conducted no further actions or tests.

Wisconsin Farmers Union is extremely concerned with any attempt to limit utility liability for stray voltage. Farmers are not traditionally a litigious group. If a level was presented that could adequately protect both farmers and the utilities, it would certainly merit close scrutiny. However,

[10] *http://www.uwex.edu/uwmril/pdf/StrayVoltage/03_What_do_we_know_about_Stray_Voltage.pdf*
[11] *Id.*
[12] Wisconsin PSC Docket 05-E1-106, pages 10-11.

given the current suggested cut off level for liability, the testing methods used to determine stray voltage, and the fact the PSC still does not recognize "non-traditional" stray voltage to be a potential threat to cows, WFU cannot support the current bill that will soon be introduced to the state legislature.

This Bill Would Bar Cases of "Non-traditional" Stray Voltage

The Wisconsin Public Service Commission narrowly defines "stray voltage" as voltage that is present across points (generally grounded metal objects), in which an electrical current is produced when an animal simultaneously contacts two conductive points to complete a circuit, which allows an electrical current to flow.[13] This type of stray voltage occurs when current is passing through a point with which a cow can potentially come into contact. However, a cow can essentially escape this current by leaving or avoiding the source. The *Hoffmann* case referenced a different type of stray voltage or ground current. This is current that is running constantly through the earth which is constantly hitting the cows and from which they cannot escape. These currents run at much smaller voltage levels than traditional stray voltages do. The utility argued that because the "non-traditional" stray voltage was measuring at levels below 1 mA, the currents could not harm the cows. The Hoffmanns, however, successfully argued that long term exposure to low levels of non-traditional voltage was having negative effects on their cattle.

If this proposed bill goes into effect, it would limit utility liability as long as they are following the PSC's rules and regulations. However, the PSC has no provision for taking "non-traditional" stray voltage into account. This bill would essentially bar all non-traditional stray voltage cases since the voltages levels of non-traditional stray voltage are typically below 1 mA. This means farmers like the Hoffmans who experienced $1.2 million worth of damage for more than a ten year period of time will have no means of recourse to be made whole.

The *Hoffmann* case has forced utilities to be more proactive in mitigating even low levels of stray voltage on farms. Lawsuits over stray voltage have dropped significantly because the case forced the utilities to become more proactive. Legislating around the findings of the *Hoffmann* decision would essentially undue everything positive that has happened regarding stray voltage since 2003. Utilities will be less likely to mitigate even low levels of stray voltage, and farmers will be left to pick up the slack financially as a result. Farmers have nothing to gain and much to lose as a result of this bill, which is why Wisconsin Farmers Union strongly opposes it.

[13] *Hoffmann v. WEPCO*, 262 Wis. 2d 264 (Wis 2003)