

# Public Service Commission of Wisconsin

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April 19, 1999

To The Person Addressed:

Re: Steady State

The Stray Voltage Analysis Team (SVAT) has become aware that there exists some confusion among many of the utility Agriculture Representatives as well as others in the industry about the exact definition of "steady state" in referring to cow contact voltages and currents. This letter is intended to clarify this confusion by outlining the history of this aspect of stray voltage investigations and to state the Public Service Commission's (Commission) definition of "steady state."

In August of 1989, the Commission issued its Finding of Facts, Conclusion of Law and Orders relating to stray voltage. In this order (docket 05-EI-106) the Commission defined stray voltage as follows:

"Stray" voltage is a special case of voltage in which the neutral-to-earth voltage is present across points (generally grounded metal objects) in which a current flow is produced when an animal comes into contact with them. As will subsequently be discussed, these contact points can include any two conductive points, which the animal may simultaneously contact to complete a circuit, which allows current to flow. Stray voltages are low-level voltages and should be distinguished from painful shocks felt by humans.

In this order, the Commission found that a 0.5-volt standard supports a 1 milliampere (AC RMS 60 Hz) steady state standard, which is used by the Commission as the "level of concern." The AC, RMS 60Hz is implicit, but not specifically written. This assumes a nominal resistance for the cow in its environment to be 500 ohms. The Institute of Electrical and Electronics Engineers (IEEE) defines steady state as "the value of a current or voltage after all transients have decayed to a negligible value. For an alternating quantity, the root-mean-square value in the steady state does not vary with time."

In its docket 05-EI-115, the Commission determined that a special "level of concern" for motor starting transients was not required. Transient voltages and currents from motor starts, as well as other switching devices, are consequently, by definition, not steady state values. Also, the RMS value, refers to the 60 Hz fundamental voltage or current and not to any harmonic content which may or may not be present in addition to the fundamental frequency. Other transients that are

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not included in the Commission orders are high frequency transients (>3 kHz) induced from sources outside the distribution power system.

Also in the Commission docket 05-EI-115 order, the value for "level of concern" was increased from 1 milliampere to 2 milliamperes AC RMS 60 Hz, steady state. This is a very conservative, preventive level, below the point where moderate avoidance behavior is likely to occur and well below where a cow's behavior or milk production would be harmed. The "level of concern" is not a damage level. The inclusion of the reference to AC, to RMS, to 60 Hz and to steady state was explicit and was necessary to provide an exact meaning to the measurement.

In all stray voltage investigations, the use of voltage recording equipment is a valid test. During analysis of the recorded voltages, the maximum voltage reports (non-steady state) should be used for diagnostic and research purposes only. The RMS steady state reports should be the only values used to determine if the cow contact voltage/current exceeds the "level of concern."

There are many valid tests which produce useful information in a stray voltage inquiry. In Commission docket 05-EI-106, a standard diagnostic measurement test technique or protocol was discussed. It states that five tests should be basic to any stray voltage investigation seeking to find the source of a stray voltage problem. These five tests should be used at some point during a stray voltage inquiry if the source of stray voltage has not previously been identified. Load testing for on- or off-farm contributions is typically not part of an initial or preliminary (Phase I) stray voltage inquiry. If the source has been determined by some valid means, such as but not limited to data supplied by a recording voltage meter, some or all of these five tests may not be required. Stray voltage testing and diagnostic procedures and protocols continue to be utilized on a case by case basis for the type of inquiry needed. More often than not, the site-specific characteristics of a stray voltage investigation will require some flexibility on the part of the investigator and generally precludes the use of uniform tests in all situations. This flexibility of investigators is critical during preliminary testing to produce the most satisfactory results as quickly as possible.

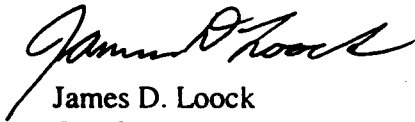
It is important to point out that investigators can expect to find 2 milliamperes or less on 88 percent of all farms investigated and 1 milliampere or less on 62 percent of all farms investigated. We would expect only 2 percent of the investigations to yield values higher than 6 milliamperes. In the Commission docket 05-EI-115 order, Ultimate Finding Of Fact No. 4, the Commission found that above 6 milliamperes, a cow's behavior response can become severe and milk production may be reduced due to changes in the animal, such as increased stress hormone levels. This means that on 98 percent of the farms investigated, the SVAT expects neither adverse herd health effects nor loss of milk production, influenced by behavioral changes due to stray voltage (as defined by the Commission) from on-or off-farm sources.

This letter should not be interpreted as a method to discourage your customers from establishing a cow contact level of their choice. Isolation on demand, equipotential planes, four-wire systems, or other mitigation techniques are available to farmers, regardless of whether stray

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voltage exceeds the "level of concern." Commission orders are in place to ensure reliability and safety for utility staff and it's customers. We hope this letter clears up any confusion surrounding these issues.

Sincerely,



James D. Loock  
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Electric Division



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