Date Mailed
07-16-96

BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

Investigation on the Commission's Own Motion Into the Practices, Policies and Procedures Concerning Stray Voltage for Electric Distribution Utilities in Wisconsin — 05-EI-115

FINDINGS OF FACT, CONCLUSION OF LAW, AND ORDER

Background

This case updates earlier decisions by the Public Service Commission (Commission) about stray voltage and its effects on livestock. The Commission first investigated this subject in 1987, and 1988, culminating in an order issued in docket 05-EI-106 on January 18, 1989. The Commission amended this order on August 11, 1989, to address the need for coordination between electric and telephone utilities when neutral isolation is installed. It also reopened the case to consider neutral isolation practices further. On July 23, 1990, the Commission issued a Supplemental Order specifically about neutral isolation. On September 7, 1990, the Commission amended the Supplemental Order, when it denied a petition for rehearing, to clarify that, if a utility's system generates stray voltage greater than 1.0 milliampere (mA) and the utility fails to mitigate the stray voltage problem according to Commission orders, it is not providing adequate service.

The Commission made clear, in its 1989 Amended Order, that it intended to reconsider Commission policies as new research came to light. For example, when the Commission set the level of concern at 1.0 mA AC RMS 60 Hz, steady state, it declared, "However, the Commission will stay apprised of the on-going research and will raise or lower this standard as appropriate." It also stated, "The research as to how and what electrical factors affect livestock should be continued and Commission policy will be modified as appropriate based on this new research." (Docket 05-EI-106, Amended Order, pages 6 and 7.) Believing that it was time to reevaluate the

state of the science on stray voltage, the Commission opened this docket by issuing a Notice of Hearing on January 22, 1996. The Notice states:

> The purpose of commencing the investigation in this docket is to evaluate the results of the stray voltage research that has been completed since 1989, and update the original orders in docket 05-EI-106. Review of the research will allow the Commission an opportunity to update its policies regarding stray voltage, if necessary.

The Notice also made clear that this investigation is about stray voltage, not about electromagnetic fields, direct currents, or ground currents on farms. The Commission addressed those issues last year, in docket 05-EI-108.

The parties mutually agreed upon issues for hearing in this investigation at a prehearing conference. Twelve issues were set forth:

1. What new research or data has become available since the order in docket 05-EI-106? USDA Study 696 can be introduced into evidence as part of this issue.

2. What is the appropriate level of concern, and what are the appropriate remedies when the level of concern is reached?

3. What are the utilities' present policies and procedures on stray voltage?

4. Should a standard be established for primary neutral to reference voltages? Who does the testing to see if the standard is met?

5. Is copperweld distribution conductor no longer safe, reliable, and adequate for use because it can produce stray voltage above the "level of concern?"

6. When should isolation be available and for how long? What safety and reliability concerns need to be addressed when isolating customers?

7. Who pays for isolation?

8. Should on-farm mitigation be owned by the utilities?

9. Should the Commission update test procedures and reports to customers? If so, what should the procedures and reports be?

10. What does the data show about motor starts affecting cows behaviorally? Should there be a milliampere level of concern on motor starts? And if so, what should that limit be?

11. Should farmers be considered special needs customers?

12. Should on-farm mitigation be allowed for off-farm problems?

The Commission held twelve public hearings on these matters, traveling around the state to Platteville, Fond du Lac, Green Bay, Chippewa Falls, La Crosse and Marshfield, on November 6, 7, 8, 13, 14 and 15, 1995, to solicit the testimony of farmers and others. In Madison, beginning on February 19, 1996, the Commission also held five days of technical hearings to receive testimony from each party's witnesses and from Commission staff. At these technical hearings, the Commission heard researchers, scientists, field investigators and members of the State of Wisconsin Stray Voltage Analysis Team (SVAT) about these issues. The rest of this order will discuss and resolve these twelve issues.

FINDINGS OF FACT

Issue 1: What new research or data has become available since the order in docket 05-EI-106? USDA Study 696 can be introduced into evidence as part of this issue.

The major work published on this subject is the U.S. Department of Agriculture's Effects of Electrical Voltage/Current on Farm Animals, Agriculture Handbook Number 696: December, 1991. The USDA Handbook was entered into the record and the Commission finds it a highly credible source of detailed information about stray voltage. The USDA Handbook's Foreword indicates that it was written by consensus among the contributors, all of whom agreed that the work was "factually correct and a faithful representation." The Foreword also declares that no industry funding was accepted, to eliminate even the appearance of bias. The Commission agrees with University of Wisconsin Professor Douglas Reinemann's comment that the USDA Handbook "is an excellent summary of research conducted up to the date of its publication."

Chapter 3 of the USDA Handbook, "Physiological and Behavioral Effects," summarizes research directly related to setting an appropriate level of concern, one of the primary issues in this case. An editor of Chapter 3, Cornell University Professor Daniel Aneshansley, testified at hearing. He affirmed that the conclusions in the USDA Handbook are still shared today by all of the authors. Chapter 3 concludes, "Older recommendations for tolerable levels of cow contact voltages (0.5 V (1980) and 0.7 V (1987)) were based on
the lowest values for perceived currents and low values for body, contact, path, and source impedances. These past voltage recommendations need to be reviewed in light of recent research."

In Chapter 3, Figure 3-4 graphs the results of research about the effect of different levels of steady state, 60 Hz current passing through a cow. Figure 3-4 shows that the Commission's present level of concern, 1.0 mA, is the lowest threshold at which the most sensitive cows perceive the presence of electricity. Depending on its sensitivity, a cow will begin to perceive

electric current at levels between 1.0 to 3.0 mA; the USDA study concludes that stray voltage at these levels has no effect on milk production. The former veterinarian for SVAT agreed that a sensitive cow could be safely placed in an environment with 2.0 mA of current. A moderate behavioral response will occur at current levels between 3.0 and 6.0 mA, again depending on a cow's sensitivity to electricity. The USDA Handbook declares, "Currents up to 4.0 mA do not appear to inhibit the milk ejection reflex, depress milk production significantly, or increase the incidence of mastitis or other diseases of the cow." Above 6.0 mA, a cow's behavioral response may become severe and the loss in milk production may be due to changes in the animal, such as increases in stress hormone levels. The USDA Handbook declares that information given in Figure 3-4 is "the consensus opinion of animal scientists representing most of the research completed or under way in the United States and Canada."

The Commission finds the USDA Handbook an insightful and useful compendium of research. Because research following the publication of the USDA Handbook confirms its conclusions, the Handbook remains valuable today. As of 1991, only preliminary results of long-term studies were available, but Cornell University has since completed additional research on long-term exposure to stray voltage. Professor Aneshansley reported that Cornell's full-lactation study, lasting for 305 days, showed no significant differences in milk production, milk fat, protein, somatic cell count or reproduction between groups of cows exposed to no voltage, 1.0 volt, 2.0 volts, or 4.0 volts. He also described similar findings from a long-term study performed at New Liskeard College in Ontario, Canada. These findings agree with the short-term and intermediate-term studies upon which the USDA Handbook based its conclusions.

The Farmers Union recommended that research duplicating actual field conditions should also be examined. Southwick, Appleman, and Albrecht, whose results were included in the USDA Handbook, did perform on-farm experiments. At least five of the contributors to the USDA Handbook have principal appointments through Extension Services of states with

significant dairy enterprises. Other controlled on-farm research was reported by Southwick, Wilson, and Sears, "Milk Production, Water Consumption, and Somatic Cell Count Responses of Cows Subject to 1 to 2 Volts of Alternating Current," Journal of the American Veterinary Medical Association, 201, no. 3 (August, 1992). In addition, data from field investigations in New York and Wisconsin have become available since the publication of the USDA Handbook. This material agrees with the USDA Handbook's results.

Professor Reinemann has performed a substantial amount of research on stray voltage at the University of Wisconsin. His work, initiated at the request of the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP), was designed to examine the effect on dairy cows of transient voltages, to continue research recommended in the USDA Handbook by examining the variation in cow sensitivity and response to current for a large number of animals, and to develop methods of relating responses to exposures. His report on 60 Hz electrical transients, the type of transient created by a motor as it starts to run, shows that cows need to be exposed to one cycle of a 60 Hz transient at levels 1.5 times higher than steady state current levels in order to elicit the same response.[1] The 1987 report by Currence, Steevens, Winter, Dick, and Krause, "Dairy Cow and Human Sensitivity to 60 Hz Currents," Paper No. 87-3036, ASAE, St. Joseph, Michigan, supports this conclusion.

Regarding animal sensitivity to 60 Hz, steady state current, Professor Reinemann found that the response levels presented in Figure 3-4 of the USDA Handbook are "very conservative, in that the responses cited (e.g. perception only at 1-2 milliamps) will only occur for a small percentage of cows. The vast majority of cows will not perceive currents of this level and will show no harmful effects." Other research at the University of Wisconsin has shown that stray

[1] A transient is a short-term surge of voltage and current. Starting a motor causes a transient because it draws more current than when the motor reaches full speed. See the discussion of Issue 10, below.

voltage will not reach a cow's udder through the milk pipeline, because the plastic hoses used to move milk from the cow and the milk itself are a very high resistance electrical path.

More recent research confirms that stray voltage does not directly cause health problems in a cow. For example, scientific and clinical evidence does not show an association between stray voltage and increased somatic cell counts, reproductive problems, sore feet or sore legs. Stray voltage does, however, trigger avoidance behavior, such as a reluctance to enter a stall or drink water from the water bowl. The USDA Handbook also reported that cows acclimate physiologically and behaviorally to current and voltage levels, which the more recent intermediate-term and long-term studies have confirmed. A cow may initially avoid drinking from a water bowl when stray voltage is present, but retired Cornell University Professor David Ludington reported that Cornell's research found, overall, no significant difference in water consumption between cows subject to different levels of stray voltage or no stray voltage at all.

Overall, the Commission finds that the USDA Handbook's conclusions are reasonable and are supported by research conducted since its date of publication. A scientific consensus exists about the effects of stray voltage, and that consensus can be used to set Commission policy.

Issue 2: What is the appropriate level of concern, and what are the appropriate remedies when the level of concern is reached?

> In its 1989 order, the Commission defined stray voltage. It wrote:
> "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.

(Docket 05-EI-106, Amended Order, page 5.)

The Commission also set the level of concern for stray voltage at 1.0 mA AC RMS 60 Hz, steady state, and specified mitigation actions that a utility must take when it contributes more than 1.0 mA of stray voltage to a farm.

Testimony at the hearings offered a range of opinions about the proper level of concern for stray voltage. Utility witnesses testified that the Commission's 1.0 mA level is overly conservative, relying in part on the USDA Handbook's recommendation that action be taken merely to keep cow contact voltages less than 2.0 to 4.0 volts (4.0 to 8.0 mA). One utility witness proposed at least increasing the standard to 2.0 mA, which USDA Handbook Figure 3-4 shows is the level where an average dairy cow begins to perceive stray voltage. The utilities argue that the existing 1.0 mA level of concern imposes unnecessary costs on utility ratepayers, who pay for mitigation on farms and for meritless litigation. Utilities believe that the current standard misleads farmers and generates needless concern, which may cause them to focus inappropriately on stray voltage instead of the farm's actual problems.

Private consultants offered different advice. Mr. Spark Burmaster argued that the conditions on a farm are too erratic to support a static level of concern. Mr. Brad Kolpin stated that 1.0 mA is an acceptable level of concern, although he had doubts that the concept of "level of concern" has been productive. Mr. Thomas Beane, a consulting partner of Mr. Kolpin, recommended setting the level of concern at zero mA, so there would be "no electrical concerns in the animal environment," but this is not a feasible suggestion. Both Professor Aneshansley and Professor Reinemann stated that achieving a zero standard would be impossible. Mr. Kolpin agreed with Professors Aneshansley and Reinemann that setting the standard at zero mA would probably be unrealistic.

Both DATCP and the Farmers Union recommended keeping the level of concern at 1.0 mA. The Farmers Union's representative, Mr. Mark Kastel, expressed his concern with motor start transients, which can occur at higher current levels than the level of concern. Raising the

level of concern, he argued, would proportionately increase currents drawn by motor start transients even further.

Researchers who testified for the Farmers Union, the utilities, and Commission staff did agree on two fundamental points--that Wisconsin's existing level of concern is conservative, and that some conservatism is appropriate for a dairy state like Wisconsin. Mr. David Winter, testifying on behalf of the Farmers Union, recommended keeping the present 1.0 mA standard but with the understanding that 1.0 mA "is not necessarily the level at which milk production is affected in dairy cows." The two Cornell University professors proposed increasing the level of concern, because almost no cows even begin to perceive electrical current at 1.0 mA and no production losses or other economic effects occur at this level. Professor Ludington suggested setting the standard at 3.1 mA, where moderate behavioral changes begin to occur in cows, but agreed that a more conservative level, for a more conservative dairy state, would be 2.0 mA. University of Wisconsin Professor Reinemann explained that only one percent of cows can perceive 1.0 mA of electrical current. He described this level of concern as "extremely conservative" and that doubling the standard to 2.0 mA would be "very conservative." The Commission agrees with Professor Reinemann that the collected body of research supports these conclusions.

When establishing the proper level of concern, understanding the scientific research on animal response to voltage is essential. It is also important to note, though, that stray voltage can occur from both on-farm sources and off-farm sources and the total amount is what may disturb the cow. The Commission's current level of concern, 1.0 mA, focuses entirely on the utility's contribution of stray voltage. This creates an inequitable situation. For example, if a utility causes 0.99 mA of stray voltage on a farm and the farm's electrical system adds 0.02 mA, the total exceeds the level of concern and the vast majority is due to the utility, but the utility is responsible for none of the problem. The Commission finds it reasonable to set a stray voltage

level of concern and then split responsibility evenly between the utility and the farmer; if the utility's contribution exceeds one-half the overall level of concern, it must apply mitigation measures. Since the Commission does not regulate farms or farm wiring, it is the farmer's responsibility to keep the farm contribution at/or below one-half the overall level of concern. This is a guideline for improving the farm's electrical system.

This is a dairy state. Because dairying is such a core industry for Wisconsin, reasonable regulation should set a standard for stray voltage at a conservative, preventive level. Prudence demands that the level of concern be set below the point where moderate avoidance behavior is likely to occur. The USDA Handbook does not recommend monitoring stray voltage below 2.0 mA. However, in recognition of the importance of dairying to Wisconsin, the Commission finds that a total stray voltage level of 2.0 mA is a conservative level of concern and is reasonable in this state. This is a preventive level where cows can perceive the current, but well below where a cow's behavior or milk production would be harmed. Based on the concept of equal responsibility between the utility and the farmer, the utility would be responsible for keeping its contribution of stray voltage to 1.0 mA or less.

Issue 3:What are the utilities' present policies and procedures on stray voltage?

The utilities' current policy is to respond to stray voltage calls within three working days, to the extent practicable, and to use the stray voltage tests prescribed in docket 05-EI-106, Amended Order. Mr. Beane attacked the utilities' methods, though, at one point claiming that their test procedures are "very close to being called fraudulent" and criticizing others for using procedures inconsistent with the Commission's test protocols. Mr. Beane, however, is not a credible witness. He offered contradictory testimony as to whether he follows Commission test procedures in his own work as a farm consultant, and he admitted that he tests for stray voltage outside cow contact areas. Mr. Beane does not regularly take recorded measurements or do 24-

hour tests; Mr. Beane's belief that the answers should be evident in three to five hours ignores the fact that the electrical system changes constantly during the day. His testing methods, as described in the record, are too simplistic to provide accurate results.

The Farmers Union also recommended that the Commission make uniform the tests used by utility investigators. More often than not, however, the site-specific characteristics of a stray voltage investigation will require some flexibility on the part of the investigator. The Commission finds that the utilities' current policies and procedures are reasonable. The Commission does find it appropriate to enlarge the testing protocol for utility investigations by incorporating tests for motor start transients, because these transients are commonly found on farms and data on transients will be helpful for investigators and researchers. Requiring utilities to include a 24-hour test on the farm that uses electronic recording equipment to measure these short, 60 Hz motor start transients will not unduly burden the utility investigations.

Some parties requested that the farmer should have better access to the information that utility investigators collect on a farm. The Farmers Union argued that farmers have a right to know their utility's recommendations and the basis for the recommendations. The utilities responded that some of the data can be misleading, especially primary and secondary neutral-to-reference voltage measurements because they frequently exceed 0.5 volts. The Commission agrees that the farmer should always receive a report on the results of the utility's investigation. The level of detail may vary, but it is reasonable for all reports to include information about the level of stray voltage found, the source of any current that exceeds the level of concern, the utility's farm wiring recommendations, a description of all distribution system changes the utility made, and the results of the utility's 24-hour tests.

Issue 4: Should a standard be established for primary neutral to reference voltages? Who does the testing to see if the standard is met?

The Commission first addressed the need for a primary neutral to reference voltage (PNRV) standard in its Amended Order, where it created a guideline for utilities to follow when operating their distribution systems. The Commission wrote:

> While the Commission will not establish a maximum level for primary neutral to earth voltage on a distribution line, it does note that several utilities, such as Northern States Power and Wisconsin Public Service Corporation, have internal guidelines for such levels which are useful, not only for stray voltage purposes, but also for general planning and operational management. The ranges established are from 2.5 to 5 volts on the primary neutral system, depending on the primary phase to phase voltage levels. Other utilities should submit similar guidelines or show why such guidelines are not appropriate for them. A comprehensive review process to ensure adequate planning and operation of rural distribution systems with a view to minimization of stray voltage concerns will be implemented.

(Docket 05-EI-106, Amended Order, page 14.)

Commission staff recommended converting the PNRV guideline to a standard and requiring utilities to build, operate, and maintain their rural distribution facilities in a manner that minimizes neutral-to-earth potential. Commission staff suggested that inability to comply with a PNRV standard is an early warning that utility grounds may be inadequate.

A PNRV standard may be a useful method of ensuring that utilities provide adequate service at the distribution level, but it cannot address specific stray voltage concerns. For this reason, the Commission will consider the value of such a standard in its work on ensuring adequate utility service in electric service rules docket 1-AC-164, rather than setting a PNRV standard in this docket.

Issue 5:Is copperweld distribution conductor no longer safe, reliable, and adequate for use because it can produce voltage above the "level of concern?"

Copperweld conductor consists of a core of steel wire, clad in copper, and wound with copper wires. It was commonly used until the end of World War II, when it was replaced by the

more economical aluminum conductor, steel reinforced wire. Commission staff recommended that utilities develop an inventory that shows where they are still using copperweld conductor, because it is related to higher levels of stray voltage. Mr. Winter, testifying for the Farmers Union, suggested that copperweld is no longer a good primary neutral conductor because its age makes it overly prone to breakage, weathering, poor splices and worn-out connections.

The utilities argued that compiling such an inventory would be expensive and time-consuming, requiring the review of thousands of distribution maps. They noted that the effect of copperweld on stray voltage is site-specific, and that stray voltage investigations already determine whether copperweld is present and influencing stray voltage levels. The Commission agrees that copperweld's effect on stray voltage can be reasonably evaluated in site-specific stray voltage investigations. The Commission will consider the need for monitoring requirements or performance standards for copperweld distribution conductor in its current evaluation of service quality standards, docket 1-AC-164.

Issue 6: When should isolation be available and for how long? What safety and reliability concerns need to be addressed when isolating customers?

and

Issue 7: Who pays for isolation?

Neutral isolation is a method of separating the primary and secondary neutrals. Separation prevents any off-farm sources of stray voltage from appearing in a cow contact area. A neutral isolator can, however, hide the presence of stray voltage caused by on-farm conditions without fixing the farm wiring problems involved. Installing an isolator for one farm can also push stray voltage onto neighboring farms. A properly functioning isolator reconnects the primary neutral and secondary neutral when voltage above a specified amount is applied, so fault current can use the additional grounding available on the farm to dissipate any potentially

damaging effects. The isolator reconnects the neutrals at its "breakdown voltage." Neutral isolation is discouraged, but allowed under certain conditions by section PSC 114-97 D2 of the Wisconsin State Electrical Code, Volume 1. See s. PSC 114.08, Wis. Adm. Code.

The Commission's prior orders in docket 05-EI-106 consider neutral isolation a useful short-term means of mitigating off-farm sources of stray voltage, allowing a utility time to diagnose the real cause of stray voltage and correct the problem. The Commission currently allows a utility that has identified off-farm stray voltage above the level of concern to install an isolator temporarily. The installation, though, is subject to the following conditions:

1. The utility must install the isolator at its own cost.

2. Isolation is not available for stray voltage below the level of concern.

3. Isolation is not available if it creates unsafe conditions on the farm because of lack of grounding or increases the primary neutral voltage to unacceptable levels.

4. Isolation can remain in place no more than 90 days. Beyond that period, the utility must request an extension from the Commission.

(Docket 05-EI-106, Amended Order, pages 20-26; Supplemental Order, pages 1-12.)

The utilities, Farmers Union, DATCP and Commission staff generally concur that, when off-farm sources of stray voltage exceed 1.0 mA, isolation subject to these conditions is still appropriate. The Commission agrees.

In this docket, a major issue concerns whether isolation should be available to farmers on demand, regardless of whether stray voltage exceeds the 1.0 mA utility level of concern. Both the Farmers Union and DATCP recommend that farmers be allowed to receive isolation on demand for one-year trial periods. Commission staff originally proposed a shorter, 90-day trial period, but ultimately agreed with Farmers Union and DATCP. The Farmers Union recommended that the utility should install an isolator at its own cost, but DATCP preferred that the farmer pay for installation. Both parties agreed that farm wiring must be adequate before an isolator is installed.

The utilities are concerned about allowing isolation on demand. They argued that other mitigation alternatives are safer and more effective than isolation. They were also concerned that isolation may create more litigation problems, so they recommended that it be allowed on demand only under certain conditions. The Commission agrees with most of the utilities' recommendations regarding how to implement isolation on demand, except their proposal that the utility would be able to deny a request for isolation. The Commission finds that farmers should be allowed to test whether using an isolator to reduce already low levels of stray voltage may be beneficial for milk production, and that it is reasonable to modify its isolation policy accordingly. The primary and secondary neutral conductors are connected for safety reasons but, if the utility and farm electrical systems are up to code, they can still operate safely when separated by an isolator. Inspections and maintenance of farm wiring and grounding are an important precondition to allowing isolation on demand, however, in order to ensure the farm's safety. Reasonable requirements for allowing isolation on demand are as follows:

1. Commission staff should create an isolation request form, in consultation with the utilities. The form should collect appropriate information about customer service providers that must be notified, such as the gas utility, telephone utility and cable television company. When it becomes available, a farmer who wants isolation must complete the request form.

2. The farmer must supply up-to-date certification that a state-certified electrical inspector, or a state-certified master electrician, has inspected the farm and that the farm's electrical system complies with applicable codes.

3. The utility shall conduct a stray voltage investigation, using the test procedures specified in docket 05-EI-106 and in this order, before and after isolation.

4. Isolation shall be allowed only for stray voltage concerns on operating livestock farms.

5. The utility may require that the farmer hold it harmless against any utility liability related to the requested isolation. The utilities shall bring to the Commission the wording of their hold harmless clauses, for its approval, within 30 days after the date this order is mailed.

6. The utility shall own and maintain the isolator. The utility may determine what type of isolator to use, although spark gap isolators and isolation transformers are not

recommended for isolation on demand. Each utility shall provide the customer with specifications about the isolation devices it makes available.

7. Within 60 days after the date this order is mailed, the utilities shall develop a uniform tariff for isolation service to provide farmers throughout the state equivalent access to this service. Within 30 days after the Commission approves the utilities' uniform tariff, each utility shall conform its existing stray voltage tariff to these uniform standards.

If the utility's stray voltage contribution is 1.0 mA or less, the farmer can receive an isolator on request. The farmer must pay the cost of the isolator, installation, and maintenance. If the farmer requests the utility to remove the isolator within one year after installation, though, the utility shall do so at no cost and shall reimburse the farmer the resale value of the isolator.[2]

Where a utility has installed an isolator because off-farm stray voltage exceeds 1.0 mA and the 90-day period for isolation has expired, isolation can continue if all the conditions set forth for isolation on demand are met. The utility, however, must provide the inspection of farm wiring by a state certified master electrician or state certified electrical inspector. If wiring code violations are noted, the customer must make the corrections within 60 days. If the corrections are not made, the utility must remove the isolator and install another mitigation technique to reduce the utility contribution to 1.0 mA AC RMS or below.

Spark gap isolators are poor devices for stray voltage isolation because the electrodes wear out as the isolator is used. As a result, the isolator's breakdown voltage increases and the time needed to close the gap between the neutrals becomes unpredictable. Isolation transformers are less safe than other isolation devices, because they are not designed to provide stray voltage isolation and do not reconnect the system safely during a fault condition. Isolation transformers are 1:1 transformers that a farmer can install in farm wiring, under an exception to the Wisconsin State Electrical Code, Volume 2 (National Electrical Code). Unlike a transformer on the utility pole, the neutrals on each side of an isolation transformer are not connected together and will not reconnect, even in high-voltage fault conditions. As DATCP's witness testified, an isolation

[2] Applying these conditions when a farmer uses an isolator for a one-year trial period is reasonable because it allows the farmer to test the isolator during a complete lactation period and during each season of the year.

transformer is "more complex, costly, and less safe." The Commission does not recommend use of spark gap devices or isolation transformers for stray voltage mitigation.

It is reasonable to require that utilities offer isolation in a timely manner. For the first one-year period following the date this order is mailed, each utility should install an isolator within 45 days after a proper request is received. To be proper, the request must include the wiring certification and, when the forms become available, a completed isolation request form. In subsequent years, it is reasonable for utilities to install isolators within 30 days of receiving proper requests. It is also reasonable for staff to develop guidelines and specifications that define isolation for the benefit of telephone and other non-electric utility personnel, so they know how to install or modify their equipment to achieve and maintain complete isolation.

Issue 8: Should on-farm mitigation be owned by the utilities?

"On-farm mitigation" primarily consists of equipotential planes and electronic grounding systems. Utilities frequently install these devices, or assist a farmer in paying the cost of installation, as methods of mitigating stray voltage. The Commission's current policy is:

> If the "level of concern" is exceeded and is caused by an off-farm source, the utility is responsible for the cost of installing and maintaining temporary neutral isolation. If the utility is unable to correct the problem on its own system, then, with the consent of the customer, the utility shall install, at its own expense, an appropriate other on-farm mitigation device(s) to correct the problem.
>
> If it is necessary for the utility to install on-farm devices, these are to be owned and maintained by the utility. In the event the utility does install the devices, they may be included in their rate base.

(Docket 05-EI-106, Supplemental Order, page 6.)

The parties generally disagreed with the Commission's current policy that utilities own on-farm mitigation devices. The utilities stated that the farmer should be responsible for ownership, because a farmer receives greater benefit from typical forms of on-farm mitigation

than a utility does and can routinely check the device by taking voltage measurements. Although utilities are willing to maintain these devices, they do not believe a periodic inspection program is necessary and discourage requiring one. Instead, they are willing to respond to a farmer's request for an inspection.

The Farmers Union's expert witness recommended that utilities should not, as a general rule, own these on-farm devices, and DATCP's representative noted that utility ownership can create problems simply because mitigation methods such as equipotential planes become part of the farm's real property when they are installed. For these reasons, the Commission agrees that the utility should transfer ownership of such an on-farm mitigation device to the farmer. The utility should not charge the farmer when it transfers ownership, since off-farm stray voltage has prompted installation of the mitigation device, and the utility should no longer include the device in rate base. The utility can, however, recover the reasonable expenses of installation and maintenance in rates. The utility, though, should remain responsible for maintenance and should inspect the facilities at the farmer's request. As part of a utility-provided mitigation device, the utility should include a meter or other monitoring device if the farmer is responsible for day-to-day monitoring.

Issue 9:Should the Commission update test procedures and reports to customers? If so, what should the procedures and reports be?

The Commission established a testing protocol in its Amended Order. The order prescribes a set of standardized screening tests to determine the presence of stray voltage, and five standard diagnostic measurement tests to identify its source. (Docket 05-EI-106, Amended Order, pages 9-14.)

Tests used by SVAT

Some parties raised concerns about the value of the tests used by SVAT. Mr. Beane criticized SVAT for relying on outdated tests and reports, but his testimony lacks a solid foundation. Mr. Beane, who sells a consulting service to farmers for correcting stray voltage problems, has investigated over 600 farms and found stray voltage problems or objectionable current on 95 percent of them. Mr. Beane even alleged that he had uncovered stray voltage above the level of concern on 25 farms where SVAT had previously investigated without result. Yet, even though he testified that "we need to be better communicators all the way around and work together," Mr. Beane never notified SVAT about any of these cases. Mr. Beane's credibility is further weakened by his testimony that he had cleaned up the wiring on these farms after finding the stray voltage problems that SVAT left behind, because these statements contradict his admission on the record that he does no farm wiring at all.

Mr. Beane's background does not qualify him as an expert. He admitted having no formal education as an electrician and no particular expertise in isolation transformers, taking no formal engineering classes or statistics classes, and never completing the stray voltage investigators training course. His broad criticism of researchers, veterinarians, SVAT, utilities and farm service personnel, therefore, is of little value to the Commission.

The utilities are generally satisfied with the SVAT tests and the Farmers Union supported these tests as "an excellent protocol." The Farmers Union recommended updating the tests so they specify the proper instrumentation to use, include a farm inspection for proper grounding and provide the farmer with instructions on emergency action to take for cattle or personal safety. Professor Reinemann described the SVAT tests as "a fairly robust technique," because they are designed to eliminate the possibility of an erroneous result even when generally used by other investigators in the difficult environment of a dairy barn. The Commission finds that SVAT's current protocol is a satisfactory means of testing for the presence of stray voltage and that these tests do not need to be changed.

Methods of Estimating Cow Resistance

In its earlier orders the Commission described how to calculate stray voltage levels in a cow contact area. The Amended Order recommends the use of a resistor to simulate the resistance of a cow's body. Relying on existing research that indicated 350 to 560 ohms is a reasonable range for a cow's resistance to current passing from its mouth to its rear hooves, the Commission specified that resistors in that range should be used when taking cow contact measurements. (Docket 05-EI-106, Amended Order, page 9.) The standard SVAT protocol now uses a 500 ohm resistor.

The Farmers Union's expert witness, Mr. Winter, accepted the use of a 500 ohm resistor when measuring voltage in the barn, but recommended substituting a cow's actual resistance (which may be less than 500 ohms) when calculating current in the cow contact area. He derived these "actual" figures from the USDA Handbook, Table 3-1 which he called a calculation of "True Source Voltage."

Table 3-1 gives the mean resistance of the electrical path of a cow from mouth to rear hooves as 475 ohms, but it also shows that the path from mouth to all hooves can be as low as 244 ohms. According to Ohm's Law, if voltage is held constant, smaller resistance values will increase the level of current that is calculated to be in the cow contact area.[3] Mr. Winter recommended using a low level of resistance shown in Table 3-1, in order to protect the more sensitive cows.

Different witnesses defended the Commission's current method of estimating cow resistance. Commission staff argued that "True Source Voltage" adds complexity to field calculations for no purpose. Commission staff testified that substituting a different resistance

[3] Ohm's Law states that current is equal to voltage divided by resistance. Thus, reducing resistance will increase current when voltage is held constant.

value halfway through the calculation, as Mr. Winter recommended, makes the test results less easy to reproduce and less understandable by the farmer and by the investigator.

Professor Aneshansley stated that the 500 ohm resistor reasonably characterizes a cow's resistance plus the resistance of "all contact points." He indicated that such a resistor should be higher than just the level of cow resistance, because it also simulates the resistance of the concrete barn floor and of the cow's contact with the floor. Doctor Ryder agreed. Use of the 500 ohm resistor, he said, is intentionally a most conservative, worst case situation. It calculates stray voltage levels that exceed the actual amount of current a cow in the barn would experience.

Professor Reinemann provided the most detailed explanation of why a 500 ohm resistor for both measurements and calculations is appropriate. Using a 500 ohm resistor, he said, is part of a conservative process. This process, when evaluated as a whole, is "a very reasonable method to estimate currents and in fact tends to be a worst case measurement." Professor Reinemann did tests using a 500 ohm resistor and tests on actual cows. After comparing the results, he concluded:

> Recent measurements showed that current flowing through a cow, determined with 500 ohm resistor and a 4" copper plate were 1.5 to 3 times higher than that experienced by the cow when standing in a typical stall relatively dry with minimal bedding. When bedding was removed and the pad was soaked with water the currents passing through the cow were typically within +/- 20 percent of the value measured with the 500 ohm resistor.

The Commission agrees with Professors Aneshansley and Reinemann that the resistor must represent not just the cow's resistance, but also the floor and contact resistance. The SVAT test setup eliminates the barn's floor and contact resistance because the investigator must scrape the floor clean of bedding, wash it, wet it with salt water and press a copper plate onto the floor with approximately 250 pounds of force. Using a 500 ohm resistor is a reasonable and adequate part of the testing protocol.

Issue 10: What does the data show about motor starts affecting cows behaviorally? Should there be a milliampere level of concern on motor starts? And if so, what should that limit be?

A motor initially draws more current when it starts, to overcome inertia and achieve its running speed. This is a short-term "transient" event, lasting approximately 0.02 to 0.15 second. Farmers tend to use a number of large motors to operate fans, pumps, gutter chains and grain elevators. A motor can draw up to six times more current when starting than when running. Under the 1.0 mA level of concern established in docket 05-EI-106, therefore, intermittent motor start transients could be as high as 6.0 mA in cow contact areas. The level of concern specified in the Commission's 1989 and 1990 orders applies specifically to steady state current, not to transient levels of current. Regarding motor start transients, the Commission offered a recommendation: "Wherever possible, 240 volt motors should be used and when possible and economical, soft-start motors should be used to minimize transient spikes when motors are turned on." (Docket 05-EI-106, Amended Order, page 19.)

Mr. Winter declared that cows react equally to steady state current or transient current. He referred to research by Reinemann, et al. (1994) and by Currence, Winter, et al. (1990) in support of this conclusion. As a result, he recommended broadening the Commission's level of concern so it applies to both steady state and transient currents. Applying a 1.0 mA level of concern to transients would effectively reduce the steady state level of concern to one-sixth of this level, from 1.0 mA to 0.16 mA.

Although neurological theory tends to agree with Mr. Winter's conclusions, actual testing on cows does not. Professor Reinemann ran experiments on cows to determine the threshold level at which they perceive motor start transients and offered the results as part of the record. His work indicates that the average cow doesn't begin to perceive motor start transients unless they are higher than 6.0 mA. Professor Reinemann explained that the transient current level at which aversion to feed and water become significant is approximately 1.5 times higher than the

6.0 mA level where perception begins. His conclusion that cows are less sensitive to motor start transients agrees with several other studies, performed by independent research groups that used different test methods, and with conclusions shown in the USDA Handbook.

Utilities argued against creating a special motor start level of concern, for several reasons. The utilities' witness, Mr. DeNardo, stated that the isolators in use today effectively prevent off-farm transients from appearing on a farm. DATCP's witness, Mr. Sauer, agreed that transients from the primary side can be intercepted by appropriate isolation. Mr. Sauer also stated that transients from on-farm sources can be controlled by equipotential planes and electronic grounding systems. Mr. DeNardo argued that the vast majority of transients come from on-farm sources, not from the utility's distribution system, and that these on-farm transients are uncommon, short-term events that would generally occur no more than one-fourth of a second each day. For these reasons, Mr. DeNardo concluded that off-farm sources are unlikely to affect many cows in Wisconsin.

Professor Aneshansley recommended against creating a special level of concern for motor starts, as did DATCP. Professor Aneshansley stated that the various types of recording equipment used in stray voltage investigations each measure transients differently, making it difficult to interpret the results. He believed that the Commission has appropriately defined the level of concern as a steady state voltage. Mr. Sauer drew the same conclusion, but for a different reason. He said, "Although transients represent an area of concern, with the information now available it is difficult to see how a rational standard could be established."

Motor start transients from the utility's distribution system are typically caused by large (greater than 10 H.P.), 240 volt motors on the farm. These large motors can increase current on the utility's primary neutral significantly, which may then appear on the farm and on neighboring farms through the connection between the primary neutral, the secondary neutral, and farm metallic water pipes. Generally, motors of this size violate utility service connection rules, which

are written to prevent the operation of one customer's equipment from adversely affecting service to neighboring customers. Many utilities do not now enforce their connection rules limiting motor size in rural areas, because a farm's load only rarely affects a utility's service to neighboring farms. If the Commission were to create a stray voltage standard for motor start transients, though, and thereby redefine adequate service, the utilities stated that they would need to enforce their service connection rules in rural areas more vigorously. These rules would require farmers to replace their oversized motors or install a soft-start device, either of which is an expensive option. Such a costly result should be avoided, unless the need for a motor start transient standard is clearly evident.

The 2.0 mA steady state, overall level of concern that the Commission has set in this docket, with the utility contribution capped at 1.0 mA, effectively makes a special motor start level of concern unnecessary. Reports showing that motors draw up to six times more current when starting (and therefore can create up to 6.0 mA transients from 1.0 mA of steady state current), coupled with Professor Reinemann's finding that transient current must be above 6.0 mA to be perceived by an average cow, indicate that the Commission's 1.0 mA utility level of concern is low enough that only motor start transients below the limit of perception by most cows should be found in cow contact areas.

Issue 11:Should farmers be considered special needs customers?

A "special needs" customer is one who requests or requires a higher or better level of service than is reasonably adequate for the vast majority of average utility customers. Utilities may charge a special needs customer for the additional cost of the special services they request or may require the customer to install ancillary equipment to meet these needs at the customer's own expense. The Commission's previously discussed this subject, focusing specifically on whether a farmer who receives an isolator is a special needs customer:

The Commission does not view the dairy farm customers in need of neutral isolation service because of off-farm utility conditions as "special needs" customers.

The Commission concluded that using an isolator to mitigate off-farm sources of stray voltage that exceeds 1.0 mA is simply a method of providing adequate service to that farmer, not a special service. (Docket 05-EI-106, Order on Petition for Rehearing, page 3.)

The Farmers Union, the utilities and DATCP agreed that isolating a farm because off-farm stray voltage exceeds the 1.0 mA utility level of concern does not make the farmer a special needs customer. The utility must maintain its electrical system in a manner that keeps the utility's stray voltage contribution at or below 1.0 mA; this is not the farmer's responsibility. In instances of isolation on demand, however, where the utility's contribution of stray voltage does not exceed the 1.0 mA utility level of concern but the farmer still requests isolation, the Commission found earlier in this order that the farmer should pay the cost of the isolator, its installation and its maintenance. In this situation, the farmer is a special needs customer.

Issue 12:Should on-farm mitigation be allowed for off-farm problems?

On-farm mitigation consists primarily of equipotential planes and electronic grounding systems. The utilities use these mitigation methods when they are the best engineering method of eliminating an off-farm problem that is causing stray voltage on the farm. These methods also benefit the farmer by eliminating on-farm sources of stray voltage and transient voltage, so the utilities prefer that on-farm mitigation continue to be allowed as a means of controlling off-farm sources of stray voltage.

The Farmers Union agreed that the current policy of allowing farms to be used to help solve off-farm problems should not be abandoned. It said that using a farm in this manner, though, is a privilege that should not be abused by installing on-farm mitigation when another solution is available, or when the mitigation device will create new problems on the farm. DATCP's witness encouraged the Commission to continue allowing a broad array of mitigation

methods that the farmer and utility can mutually agree upon, including on-farm mitigation for off-farm problems. "The critical element," according to DATCP's representative, "is that both parties are informed and understand the options that are available and that no coercion takes place."

The Commission finds it reasonable for utilities to continue using on-farm mitigation to address off-farm problems, if on-farm mitigation is the least costly solution and the farmer agrees to its installation.

Electric Cooperatives

The Commission does not have jurisdiction over the many electric cooperatives in this state. They are, of course, subject to the direction and control of their members. Despite this jurisdictional fact, the electric cooperatives have been helpful and involved with the proceedings in this docket and have generally followed the Commission's prior orders on stray voltage. In developing this stray voltage order, the Commission has kept the electric cooperatives in mind by trying to ensure that policies are simple, easy to implement and flexible enough to deal with specific utility situations.

ULTIMATE FINDINGS OF FACT

THE COMMISSION FINDS THAT:

Issue 1: What new research or data has become available since the order in docket 05-EI-106? USDA Study 696 can be introduced into evidence as part of this issue.

1. A scientific consensus exists about the effects of stray voltage.

2. The major work published on this subject is the U.S. Department of Agriculture's "Effects of Electrical Voltage/Current on Farm Animals," Agriculture Handbook Number 696: December, 1991.

3. The conclusions in the USDA Handbook are still shared today by all of the authors.

4. Chapter 3, Figure 3-4 of the USDA Handbook shows research results about the effect of steady state, 60 Hz current passing through a cow. Figure 3-4 indicates that 1.0 mA is the lowest threshold at which the most sensitive cows perceive the presence of electricity. Stray voltage at this level has no effect on milk production. Currents up to 4.0 mA do not appear to inhibit the milk ejection reflex, depress milk production significantly, or increase the incidence of mastitis or other diseases of the cow. Above 6.0 mA, a cow's behavioral response can become severe and the loss in milk production may be due to changes in the animal, such as increased stress hormone levels.

5. Long-term and on-farm experiments conducted after the publication of the USDA Handbook confirm the Handbook's conclusions.

6. The USDA Handbook's conclusions are reasonable and remain valuable today.

7. Recent research confirms that stray voltage does not directly create health problems for a cow. The direct response to being exposed to significant amounts of stray voltage is behavioral change. Stray voltage can trigger avoidance behavior, such as a reluctance to enter a stall or drink water from the water bowl, that has production and performance effects.

8. Cows can acclimate, both physiologically and behaviorally, to current and voltage levels.

Issue 2: What is the appropriate level of concern, and what are the appropriate remedies when the level of concern is reached?

9. The Commission's definition of stray voltage in docket 05-EI-106, Amended Order, page 5, remains valid.

10. The level of concern for stray voltage that the Commission established in docket 05-EI-106 is extremely conservative, because only one percent of cows perceive the presence of 1.0 mA of electrical current.

11. Figure 3-4 of the USDA Handbook shows 2.0 mA as the level where an average dairy cow begins to perceive stray voltage. The USDA Handbook does not recommend monitoring for stray voltage below this level.

12. Reasonable regulation for Wisconsin, a dairy state, is to set a stray voltage level of concern at a conservative, preventive level that is below the point where moderate avoidance behavior is likely to occur.

13. A conservative, preventive level of concern in Wisconsin is 2.0 mA AC RMS 60 Hz, steady state. This level of concern is well below where a cow's behavior or milk production would be harmed.

14. Stray voltage can occur from both on-farm and off-farm sources, so it is reasonable to apply the 2.0 mA level of concern as an overall standard that includes both sources. It is also reasonable to split this 2.0 mA overall level of concern equally between the utility and the farmer. The utility's level of concern is therefore 1.0 mA, for stray voltage from off-farm sources, and the farmer's level of concern is 1.0 mA, for stray voltage from on-farm sources.

15. If the utility's contribution of stray voltage exceeds 1.0 mA, the utility must reduce its contribution to 1.0 mA or below. If the stray voltage from on-farm sources exceeds 1.0 mA, the Commission recommends that the farmer improve the farm wiring, grounding or equipment or take other measures to reduce the level from these sources below 1.0 mA.

Issue 3: What are the utilities' present policies and procedures on stray voltage?

16. The utilities' current policies and procedures are reasonable. In addition, it is reasonable for utilities to provide a report on each investigation to the farmer. The level of detail may vary, but should include the level of stray voltage found, the source of any current that exceeds the level of concern, the utility's farm wiring recommendations, a description of all distribution system changes the utility made, and the results of the utility's 24-hour tests.

Issue 4: Should a standard be established for primary neutral to reference voltages? Who does the testing to see if the standard is met?

17. A primary neutral to reference voltage standard is a useful method of monitoring the adequacy of service at the distribution level. While it does not directly address specific stray voltage concerns, a high level of PNRV in rural areas can be an indicator or precursor of potential stray voltage problems.

Issue 5: Is copperweld distribution conductor no longer safe, reliable, adequate for use because it can produce voltage above the "level of concern"?

18. The effect of copperweld conductor on stray voltage can be reasonably evaluated in site-specific investigations.

Issue 6: When should isolation be available and for how long? What safety and reliability concerns need to be addressed when isolating customers?

and

Issue 7: Who pays for isolation?

19. Neutral isolation is discouraged, but allowed under certain conditions by section PSC 114-97 D2 of the Wisconsin State Electrical Code, Volume 1. If the utility and farm electrical systems are up to code, they can still operate safely when separated by an isolator.

20. The conditions set forth in docket 05-EI-106 about the utility's use of isolation, when off-farm stray voltage exceeds 1.0 mA, are still reasonable.

21. Isolation on demand, even though off-farm stray voltage is at or below 1.0 mA, is reasonable under the conditions stated in the Findings of Fact.

22. Isolation transformers and spark gap isolators are not recommended for the control of stray voltage.

23. For one year after the date this order is mailed, it is reasonable for utilities to offer isolation within 45 days after receiving a proper request. In following years, it is reasonable for utilities to install isolators within 30 days of receiving a proper request.

24. It is reasonable to require the utilities to develop a uniform tariff for isolation service in accordance with this order and to submit it to the Commission for review within 60 days after the date this order is mailed. After the Commission accepts the basic uniform tariff, each utility has 30 days to file tariff revisions that incorporate these provisions for final Commission review and approval.

Issue 8: Should on-farm mitigation be owned by the utilities?

25. It is reasonable for farmers to own on-farm mitigation devices, rather than having utilities own these devices as the Commission had originally declared in its 05-EI-106 orders.

Issue 9: Should the Commission update test procedures and reports to customers? If so, what should the procedures and reports be?

26. SVAT's current tests are a reasonable means of testing for the presence of stray voltage.

27. The use of a 500 ohm resistor to simulate the resistance of the cow, the concrete barn floor and the cow's contact resistance is reasonable. Using a 500 ohm resistor in the testing protocol is conservative, because it calculates stray voltage levels that equal or exceed the actual amount of current a cow in the barn would experience.

28. The site-specific nature of a stray voltage investigation requires some flexibility on the part of the investigator and generally precludes the use of uniform tests in all situations. It is reasonable for utilities to incorporate 24-hour tests for motor start transients in their test procedures.

Issue 10: What does the data show about motor starts affecting cows behaviorally? Should there be a milliampere level of concern on motor starts? And if so, what should that limit be?

29. A motor initially draws up to six times more current when starting than when running, to achieve its running speed. This is a short-term "transient" event, lasting approximately 0.02 to 0.15 second.

30. Under the 1.0 mA utility level of concern, a motor start transient could be as high as 6.0 mA in cow contact areas.

31. Cows are less sensitive to short motor start transients and do not perceive them as readily as steady state current. An average cow will begin to perceive motor start transients only when they are above 6.0 mA.

32. A special level of concern for motor start transients is not needed, because the Commission's 1.0 mA utility level of concern set in this order will simultaneously control motor start transients that exceed 6.0 mA.

Issue 11:Should farmers be considered special needs customers?

33. It is reasonable to reaffirm the Commission's earlier decision in docket 05-EI-106 that a farmer is not a special needs customer because of off-farm utility conditions, such as off-farm stray voltage. A utility that installs an isolator to mitigate off-farm sources of stray voltage that exceed the 1.0 mA utility level of concern is not providing a special service to the farmer.

34. A utility that installs an isolator on the request of the farmer, when off-farm sources of stray voltage do not exceed the 1.0 mA utility level of concern, is providing a special service to the farmer beyond its basic utility obligation and the farmer is responsible for costs associated with this service, as described in the Findings of Fact.

Issue 12:Should on-farm mitigation be allowed for off-farm problems?

35. On-farm mitigation should be allowed for off-farm problems, if it is the least costly solution and the farmer allows the installation to occur.

CONCLUSION OF LAW

THE COMMISSION CONCLUDES THAT:

It has jurisdiction under ss. 196.02(1)(7), 196.03, 196.28 and 196.37, Stats., to enter this order concerning stray voltage and electric utilities, as defined in s. 196.01(5), Stats.

ORDER

THE COMMISSION THEREFORE ORDERS THAT:

1. Within 60 days after the date this order is mailed, the electric utilities shall develop a uniform tariff for isolation on demand. This tariff shall be based on the 2.0 mA AC RMS 60 Hz, steady state, overall level of concern and 1.0 mA AC RMS 60 Hz, steady state, utility level of concern set forth in this order, and shall comply with the conditions for isolation on request set forth in the Findings of Fact, Issues 6 and 7. Within 30 days after the Commission accepts this basic uniform tariff, each electric utility shall file revisions to its stray voltage tariff so it conforms to the uniform tariff and to the provisions of this order. Within 90 days after the date this order is mailed, each electric utility shall also file revisions to its stray voltage tariff so the tariff conforms to the provisions of this order where the utility has installed an isolator because off-farm stray voltage exceeds 1.0 mA and where the 90 day period for isolation has expired.

2. Each electric utility shall include 24-hour motor start transient tests with electronic recording equipment in their stray voltage investigations. SVAT staff may be consulted for guidance on appropriate instruments and methods for conducting these tests.

3. Each electric utility shall provide a report to the farmer after completing a stray voltage investigation. The report shall include, at a minimum, information about the level of stray voltage found, the source of any current that exceeds the level of concern, the utility's farm wiring recommendations, a description of all distribution system changes the utility made, and the results of the utility's 24-hour tests.

4. If an electric utility installs an on-farm mitigation device to control off-farm stray voltage, the utility shall transfer ownership to the farmer without charge. The utility shall continue to maintain the device and shall inspect it on request. An electric utility may only

install an on-farm mitigation device to control off-farm stray voltage when it is the least costly solution and the farmer agrees to its installation.

Dated at Madison, Wisconsin _____

By the Commission.

_____

Lynda L. Dorr
Secretary to the Commission

LLD:DMD:tlh:H:\ORDER\05EI.115

See attached Notice of Appeal Rights

Docket 05-EI-115

Notice of Appeal Rights

Notice is hereby given that a person aggrieved by the foregoing decision has the right to file a petition for judicial review as provided in s. 227.53, Stats. The petition must be filed within 30 days after the date of mailing of this decision. That date is shown on the first page. If there is no date on the first page, the date of mailing is shown immediately above the signature line. The Public Service Commission of Wisconsin must be named as respondent in the petition for judicial review.

Notice is further given that, if the foregoing decision is an order following a proceeding which is a contested case as defined in s. 227.01(3), Stats., a person aggrieved by the order has the further right to file one petition for rehearing as provided in s. 227.49, Stats. The petition must be filed within 20 days of the date of mailing of this decision.

If this decision is an order after rehearing, a person aggrieved who wishes to appeal must seek judicial review rather than rehearing. A second petition for rehearing is not an option.

This general notice is for the purpose of ensuring compliance with s. 227.48(2), Stats., and does not constitute a conclusion or admission that any particular party or person is necessarily aggrieved or that any particular decision or order is final or judicially reviewable.

Revised 4/22/91

Docket 05-EI-115

APPENDIX A
(CONTESTED)

In order to comply with s. 227.47, Stats., the following parties who appeared before the agency are considered parties for purposes of review under s. 227.53, Stats.

Public Service Commission of Wisconsin
(Not a party but must be served)
610 North Whitney Way
P.O. Box 7854
Madison, WI 53707-7854

DEPARTMENT OF AGRICULTURE, TRADE AND CONSUMER PROTECTION
by
Mr. Steven D. Sauer
P.O. Box 8911
Madison, WI 53708-8911
(PH: 608-224-5055 / FAX: 608-224-5034)

WISCONSIN FARMERS UNION
by
Mr. Frank Jablonski, Attorney
7 North Pinckney Street
Madison, WI 53703
(PH: 608-258-8511 / FAX: 608-251-7870)

WISCONSIN ELECTRIC COOPERATIVE ASSOCIATION (WECA)
BY
Mr. Denis R. Vogel, Attorney
Wheeler, Van Sickle & Anderson, S.C.
25 West Main Street, Suite 801
Madison, WI 53703
(PH: 608-255-7277 / FAX: 608-255-6006)

DENNIS AND SHIRLEY ROEHRBORN,
PAUL AND SUE PETRIE,
MARVIN AND DOROTHY PETRIE, AND
JACK AND SUZANNE REBER
by
Mr. Scott Lawrence, Attorney
403 South 4th Avenue
P.O. Box 117
St. Nazianz, WI 54232
(PH: 414-773-2811 / FAX: 414-773-3017)

WISCONSIN UTILITIES ASSOCIATION AND
WISCONSIN ELECTRIC POWER COMPANY
by
Mr. Terrence C. Thom, Attorney
Quale, Feldbruegge, Calvelli,
Thom & Croke, S.C.
310 West Wisconsin Avenue, Suite 1000
Milwaukee, WI 53203-2293
(PH: 414-271-2266 / FAX: 414-276-0417)

WISCONSIN ELECTRIC POWER COMPANY
by
Mr. Charles M. DeNardo
333 West Everett Street
Milwaukee, WI 53203

GTE NORTH INCORPORATED
by
Mr. David E. Hightower, Attorney
100 Communications Drive
P.O. Box 49
Sun Prairie, WI 53590
(PH: 608-837-1771 / FAX: 608-837-1733)

MR. A.P. SZEWS, PH.D., P.E.
12223 West Ohio Avenue
West Allis, WI 53227
(PH: 414-321-9377)

MR. BRAD KOLPIN
Rural Route 1
Westfield, WI 53964
(PH: 608-296-3113)

MR. SPARK BURMASTER
Rural Route 1, Box 77A
Chaseburg, WI 54621
(PH: 608-483-2604)

MR. TOM BEANE
N3540, County Trunk G
Fort Atkinson, WI 53538*
(PH: 414-563-3151)

THE ELECTROMAGNETICS RESEARCH FOUNDATION, INC.
by
Mr. Wallace R. Daggett, Director
P.O. Box 44
Random Lake, WI 53075-0044

WISCONSIN PUBLIC SERVICE CORPORATION
by
Mr. Vern Peterson
700 North Adams Street
P.O. Box 19001
Green Bay, WI 54307-9001
(PH: 414-433-1030 / FAX: 414-433-1758)

WISCONSIN POWER AND LIGHT COMPANY
by
Ms. Mary Nahn
222 West Washington Avenue
Madison, WI 53703

MR. JEFF FRAHM
1822 County Road M
Athens, WI 54411

Docket 05-EI-115

MR. LEONARD FRAHM
1818 County Road M
Athens, WI 54411

NORTHERN STATES POWER COMPANY
by
Mr. Brian Guenther, P.E.
NEV Supervisor
100 North Barstow Street
P.O. Box 8
Eau Claire, WI 54702-0008
(PH: 715-839-2621 / FAX: 715-838-4308)

ROY AND LORI LEMMENES
N11135 Cottonwood Road
Waupun, WI 53963

*Address Change