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Jacqueline K. Reynolds
Secretary to the Commission
Public Service Commission of Wisconsin

BEFORE THE
PUBLIC SERVICE COMMISSION OF WISCONSIN

Investigation on the Commission's Own Motion)
Into the Practices, Policies and Procedures) 05-EI-106
Concerning Stray Voltage for Electric)
Distribution Utilities in Wisconsin)

FINDINGS OF FACT, CONCLUSION OF LAW
AND AMENDED ORDER

Proceedings

On August 18, 1987, the Commission commenced this proceeding to gather information about stray voltage by issuing a Notice of Investigation and Technical Conference. A technical conference was held on August 31, 1987, to define the issues and to help establish a hearing schedule. Subsequently, the Commission issued a Notice of Public Hearings on September 29, 1987, announcing public hearings to be held around the state in cooperation with the Department of Agriculture, Trade and Consumer Protection. Public testimony from farmers, electricians, utilities and others was received at these hearings conducted by Commissioner George R. Edgar and held at 1:30 p.m. and 7:30 p.m. at the following towns and dates: Portage on October 13, 1987; Darlington on October 15, 1987; Rice Lake on October 20, 1987; Whitehall on October 21, 1987; Richland Center on October 22, 1987; Kewaunee on October 26, 1987; Ripon on October 27, 1987; Jefferson on October 28, 1987; Belgium on October 29, 1987; Merrill on November 2, 1987;

Marshfield on November 3, 1987; Burlington on November 9, 1987; Waupaca on November 10, 1987 and Oconto on November 11, 1987. A questionnaire from the Commission to the major investor-owned utilities, the Wisconsin Electric Cooperative Association and the Municipal Electric Utilities of Wisconsin, was sent on November 18, 1987, to request information on stray voltage practices and policies.

On February 26, 1988, a Notice of Prehearing Conference was issued. A prehearing conference was held on March 7, 1988, in Madison to discuss the format for upcoming technical hearings concerning stray voltage. A Notice of Further Hearing was mailed on March 22, 1988. Hearings were held from April 12-15, 1988, before Commissioner George R. Edgar. Expert testimony was presented by the utilities, a series of witnesses on behalf of the Stray Voltage Task Force and the Stray Voltage Assessment Team.

The Commission initially discussed this docket at its open meeting of August 9, 1988. Subsequently, a Notice to Solicit Additional Comments on neutral isolator policy was issued on August 19, 1988. The Commission reviewed and discussed these additional comments at its open meeting of October 18, 1988.

A notice of appeal rights appears in the attached Appendix A. The parties, for purposes of review under sec. 227.53, Stats., are listed in Appendix B. Other persons who appeared are listed in the Commission files.

Findings of Fact

THE COMMISSION FINDS:

The public and technical testimony in this proceeding has provided a great deal of information concerning stray voltage. The Commission acknowledges the serious impacts that stray voltage problems have had and can have on farmers. While various opinions have been given about the extent to which stray voltage is a problem in Wisconsin, there is little dispute about the consequences to a farmer who does have stray voltage. We will continue to seek information on the extent of the problem, but like other parties we do not need a precise answer to know that we should be involved in solving a problem which does affect Wisconsin livestock operators.

There is a history to stray voltage in Wisconsin which the parties in this proceeding have put aside to focus on what should be done now and in the future to deal with the problem. It is in that vein of cooperation that the Commission discussed its general policies in this order. We do not mean by listing requirements of what should be done to suggest that some of them are not being done. Rather, our decision attempts to set forth procedures, guidelines and actions which constitute an effective framework for preventing and resolving stray voltage problems. While we will meet our regulatory responsibilities, our decision is written from the perspective of the cow which is more concerned about not having a problem than arguing about who is responsible for it. We believe that where responsibility is clear that appropriate

action should be taken to recognize the losses caused in a timely manner.

"Stray voltage" can cause serious financial and psychological stress for a farmer and his or her family, as well as behavioral stress for livestock in confined facilities. Fortunately, stray voltage is a solvable problem in the vast majority of cases. But, all the parties involved, farmers, utilities, electricians, farm equipment producers and installers, government agencies, veterinarians and the financial community, must understand the problem and cooperate to resolve it. To date, some farmers, electricians and the utilities have attempted to respond to stray voltage concerns. The Commission in this decision sets forth its policies and responses to this problem.

There are several basic principles upon which this Commission decision is premised. First, it is better to prevent a problem than to solve it after it has happened. Good fundamental planning, operation and maintenance on both sides of the meter; i.e., on the utility's and the farmer's electric systems, are necessary to minimize stray voltage problems. Second, it is better to remove the source of the problem than to only mitigate it. While mitigation may be necessary for some period of time to allow the problem source to be removed, the goal should be to find and correct causes. Third, each situation must be approached and analyzed based on its specific facts. While stray voltage problems can be caused by both on and off-farm sources, only a specific analysis for each farm will indicate whether there is a

problem and what its source is. Fourth, livestock are adversely affected by many causes which manifest similar symptoms to those caused by stray voltage. While a farmer should certainly check for stray voltage, he or she needs to consider all causes, including electrical and nonelectrical ones, when his or her livestock experience production or behavioral problems.

"Stray" voltage is a term that has often been used to describe different situations. It is important to have a common understanding when terms are used to distinguish between "stray" voltage and neutral to earth voltage. Neutral to earth voltage is voltage measured from the electrical system neutral and/or any structure bonded to this neutral to earth (e.g., to a driven reference ground). Neutral to earth voltage is always present at some level on a multiple-grounded neutral primary electrical distribution system, and on a farm electrical system, as the result of the electrical current flow in a multiple-grounded electrical system. "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.

Based on available research, there is insufficient evidence to conclude that stray voltage causes a direct physiological impact on animals. However, there is evidence that stray voltage can cause stress and behavioral impacts through stress on animals to the point where the animal is reluctant to eat and drink, thereby causing milk production to decrease as well as creating the circumstances for additional physical and manageability problems. These problems can cause serious economic hardship to a farmer or can indirectly result in an animal's death, and provide the reasons that corrective action should be taken if unacceptable levels of stray voltage exist. Because of evidence from farmers of the possible physiological and reproduction problems caused by stray voltage, 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.

1. Level of Concern

Existing research has led many of the Wisconsin utilities to use .5 volts as the level of concern (i.e. the point at which the average cow's behavior may be adversely affected) in their stray voltage investigations. As previously noted, "stray" voltage is the voltage difference between points. However, it is actually the current flowing through the animal that affects it and, therefore, the Commission finds that the level of concern should be stated in milliamperes: the measurement unit of current flow. The Commission finds that the existing research which underlies

the .5 V standard supports a 1 milliamperere steady state standard which will be used by the Commission as the level of concern. However, the Commission will stay apprised of the on-going research and will raise or lower this standard as appropriate.

2. Desirability of Standardized Screening and Diagnostic Measurements and Equipment

There are several reasons to use standardized measurements, both to screen for the presence of stray voltage and to diagnose the source. First, they will provide a consistent systematic analysis which can readily be documented and duplicated. Second, they can avoid needless controversy over whether an adequate analysis was performed or whether the nature of the tests were valid. Third, they can recognize the various interests of parties working on a stray voltage analysis. For example, standard tests to determine whether a problem has an on- or off-farm source can be used to reduce the time an electrician must spend on a farm and bill a farmer.

There are many valid tests which produce useful information in a stray voltage inquiry. The standard measurement tests which this decision will establish are designed to recognize those tests which the experts have indicated are the most useful in resolving most stray voltage problems. The testimony and exhibits of Gustafson et al., Surbrook and Bodman all present well-tested and usable test formats from which the Commission has borrowed. These standard measurements, plus the requirement that adequate documentation be maintained by the utilities to fully analyze the

result of each test, should provide confidence that if stray voltage was present, it would be detected and its source ascertained.

3. Standardized Screening Tests

a. Use of "Cow Contact" Areas

The most important measurement areas are "cow contact" areas where the animal can simultaneously access two points of different voltage of sufficient magnitude to cause an objectionable current to flow through the animal. These "cow contact" points or areas primarily include the milking, feed and watering areas. While measurements from the primary or secondary neutral to a reference ground can be valuable to take, the measurements of main interest should be in those areas where the cow can close a circuit to allow current to flow. Care should be taken not to take measurements where the points to be measured are bonded together by some means (e.g. water line to pipeline). In addition, measurements should be taken at various times of the day but particularly during times of high electric load (i.e., milking times) and in different locations.

The measurements taken in the cow contact areas seek to determine the strength of the current accessing the cow. This is dependent on the voltage and resistance and can be calculated by the use of Ohms Law: current equals voltage divided by resistance. For example, .001 amperes (1

milliampere) is produced by a voltage of .5 volts divided by a total resistance of 500 ohms. Since, voltage can be measured, it becomes necessary to determine the total resistance in any cow contact circuit to calculate the strength of the current. But, total resistance is in fact a composite of several distinct resistances: that of the path through the cow, that between the cow's hooves and the floor and that of the concrete floor itself. Thus, in making cow contact measurements it is necessary to use a resistance that reasonably approximates the effective resistance of the cow in the circuit.

b. Use of Resistors

Existing research indicates that a reasonable range for the resistance of the mouth to rear hooves path in a cow is from 350 to 560 ohms. Therefore, when taking cow contact measurements, resistors in the 350 to 560 ohm range should be used to simulate the resistance of the path through the cow. While higher voltage and current readings will result where a resistor is not used, the goal is to determine the sustained level of the current actually impacting the cow.

While the use of appropriate sized resistors simulates one part of the total resistance, there are other resistances which must also be addressed. Research has indicated, in order to simulate the contact resistance between the cow's hooves and the floor, that a 4-inch copper plate or some similar object under pressure be used. Simply, touching the

probes of a voltmeter to the concrete floor will only by happenstance provide a useful reading.

The resistance of the concrete floor will also vary due to factors such as the age, thickness or moisture content of the concrete. Research has indicated that this contact resistance can be neutralized by the application of salt water to the 4-inch copper plate when measurements are taken.

c. Tools to Measure

Many stray voltage problems can be detected by a simple voltmeter which can distinguish between ac and dc voltages and which is either digital or has a high impedance. However, because some stray voltage problems may only be evident at certain times of the day or when certain equipment is turned on (i.e., transient voltage), the use of a recording voltmeter may be necessary. The recording voltmeter can chart voltage levels over time (preferably at least over a 24-hour period) without interrupting the dairy operator's schedule. This meter is a valuable tool to screen for stray voltage problems when they are not immediately detected by the use of instantaneous voltage readings.

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 nonelectrical

factors. The Commission expects that additional efforts beyond the basic screening tests will be pursued when those observations justify such further action. We also recognize that the screening procedures used by the utilities now take a wide range of measurements in numerous locations and find these procedures to be appropriate and useful.

4. Standard Diagnostic Measurement Tests

Based on the measurement techniques recommended by the experts in this case, the Commission finds that the following five tests should be basic to any stray voltage investigation seeking to find the source of a stray voltage problem. Because stray voltage is affected by daily seasonal and geologic conditions, these tests may need to be repeated at various times.

a. Primary/Off-farm

There are two tests which may indicate whether a stray voltage problem comes from the primary distribution system or from an off-farm source transmitted over the primary system. The first test requires the power to the entire farm to be disconnected by opening the main disconnect (e.g., pole top switch). Adding only 240 volt farm loads to the transformer will introduce a current flow on the primary system. This can be done with a load box or on-farm 240 V load. Both neutral to earth and cow contact voltage readings should be monitored. Readings should be taken at various times of the day as loads on the primary system change. If the 240 v

loads produce increased neutral and cow contact levels, there may well be an off-farm problem.

The second test, which should be used when all the other tests discussed in this section do not indicate the source of a stray voltage problem, is to open the connection between the primary and secondary neutrals and any other possible bonds such as the telephone or cable television connections. Both neutral to earth and cow contact voltage readings should be monitored. This test could reveal a ground fault or other problems off the farm. Utilities should cooperate with electricians who wish to conduct this test if all other tests have not revealed the source of a stray voltage problem and there are no safety concerns involved due to the secondary wiring and grounding systems, particularly the absence of grounding on the farm.

b. On-farm Tests

These three tests should be conducted after the first off-farm test using only 240 V loads. The first on-farm test is to measure from the barn panel neutral to a reference ground which is away from any other grounds or metal in direct contact with the earth. Measuring from equipment in the barn to either the secondary neutral bus or a reference rod will indicate whether the equipment is either not bonded or is inadequately grounded.

The second on-farm test is intended to find excessive neutral voltage drop on the neutral conductor to buildings on

the property. A known load such as a portable 120 V hair dryer should be used, while measurements are taken between the barn service panel and the secondary neutral of the transformer (pole ground). The simple formula of voltage drop = current x length x resistance of the conductor per 100 feet divided by 100 should be used to indicate abnormal voltage levels on the farm neutral. This test is best taken with all other loads off.

The third on-farm test checks for ground faults on the farm. Testing should be done by turning on all equipment, one piece at a time, that contacts the earth. A high reading produced on the meter connected between the barn panel and the reference ground will indicate that a ground fault may be a problem.

These five tests should identify the source of most stray voltage problems. Obviously, if they do not, other means such as recording meters to check for voltages, stand-by generation tests or the use of oscilloscopes to check for high frequency problems which might be caused by electric fencers should be performed when appropriate. Any tests performed should be documented as to what was done and the results attained.

The information gained from stray voltage investigations including the frequency of occurrences, the levels which caused the problem and the sources of the problem should be built into a data base at the Commission. Therefore, the

Commission will direct the utilities to supply such information as it deems appropriate and will seek to encourage electricians involved in stray voltage investigations to cooperate in this effort.

5. Prevention

Consistent with the general principle that it is better to try to avoid problems, the Commission will ensure through its regulatory oversight that the utilities plan, build, operate and maintain their facilities with an aim to minimize the potential for stray voltage problems. In order to achieve this end, the Commission will require the utilities under its jurisdiction to conform to the following guidelines unless they can demonstrate to the Commission that said guidelines should not be applied to them.

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.

The most common rural distribution systems include three-phase four-wire, two-phase three-wire and one-phase two-wire. Much attention has been focused on three-phase secondary service derived by an open delta transformation from a two-phase three-wire primary system. The open delta transformation has the same imbalance problems that occur on a single-phase system. Several of the experts in this proceeding have recommended, that, when cost-effective, three-phase four-wire systems replace two-phase three-wire systems. This was particularly recommended as three-phase loads increase on a line which serves facilities in which livestock is confined and where no long-term mitigation techniques are in place. The Commission agrees that two-phase three-wire systems should be phased out according to a balance of factors such as service problems, timing of rebuilds, cost and load growth. Particular attention should be given to rural lines where multiple isolations due to stray voltage problems have been necessary or where rebuilds or upgrades are planned or needed. It is also appropriate to recognize that there are some existing two-phase three-wire primary lines which are not a problem and where it could be prohibitively expensive to both the utility and to farmers to change over to a four-wire system. Therefore, the Commission will have its Engineering and Energy Planning and Programs staff review utilities' submitted policies for the replacement of two-phase three-wire lines by rebuilding or adding the fourth wire. The staff should recommend an appropriate course

of action to the Commission if these policies are not adequate. Utilities' policies on this issue should be submitted within 90 days after the issuance of this order.

The Commission is also concerned about whether end-of-the-line customers are more susceptible to stray voltage problems. Testimony in this docket indicates some technical concerns such as the level of primary neutral to earth voltage under certain circumstances. Also, a number of farmers who had problems indicated that they were on the end of the line. However, the Commission believes more information is necessary and will expeditiously attempt to gather information on end of the line customers to determine if there are common factors which will allow a more complete evaluation of this question. A questionnaire seeking information on this topic will be sent to both the utilities and farmers before March 1, 1989.

The Commission on the basis of the information in this docket finds as a general policy that the utilities should adopt the following techniques to prevent or minimize the possibility of stray voltage problems unless they can demonstrate to the Commission that such actions are not appropriate on their systems.

1. The utilities should utilize guidelines for load balancing to reduce primary neutral current.
2. While nine ground rods per mile are required by code, the use of increased or special grounding such as counterpoise should be done when appropriate. However, it is

recognized that additional grounding on a distribution line may have little impact on the level of neutral voltage. Grounds should exceed code requirements and be separated, when possible, by 1-1/2 to 2 times their length.

3. The placement of the customer's central yard pole should be such as to minimize the secondary neutral voltage drop related to the service entrance. This placement should be outside of animal confinement areas. The customer's preference must also be considered in placement.

4. The use of steel conductor on primary distribution lines should be phased out. The utilities should submit reports to the Commission on the amount of steel conductor it has in service and provide a schedule for its replacement. This requirement extends to distribution static wires.

5. Line reconductorings or voltage upgrades may be necessary to prevent or to aid in the correction of a stray voltage problem. Whether this level of modification is warranted should be done on a case-by-case analysis of specific lines.

6. The removal of split-bolt connectors can aid in the mitigation as well as the prevention of a stray voltage problem. Split bolt connectors are susceptible to corrosion and other problems if not properly installed and maintained. Therefore, unless a utility provides adequate proof to the Commission that a quality control program is in

place, split-bolts should be phased out by replacing them at the time of investigation or maintenance.

7. Further review is necessary to determine if the new National Electric Code rule modification concerning the common bonding of multiple services to a farmstead will adequately address any potential problems. The utilities with multiple services should provide the Commission with relevant information as it is developed.

The Commission is strongly committed to ensuring that adequate practices and policies are in place to ensure that utility rural distribution facilities are not the source of stray voltage problems. The Commission will review the practices and policies of the utilities periodically to determine if adequate efforts are being made. To ensure that the Commission is fully informed of the practices of the utilities in this area, each utility will be required to submit the following: (1) its policy for future increase of primary voltage levels through upgrades or rebuilds, if any; (2) its rural line tree trimming policies; (3) its policy as it pertains to primary underground systems including the grounding procedures for these systems; (4) its policy on visual and/or more extensive inspections of rural distribution systems; (5) its policy on testing neutral isolators to ensure that they are operating effectively; and 6) its policy for periodically checking phase load balance and criteria for rebalancing loads on three-phase lines.

While the Commission's jurisdiction only extends to the utility side, there are also viable and effective means to prevent or mitigate stray voltage problems on the secondary or farmer's side. For example, the following practices by a farmer would go a long way to ensure that stray voltage does not become a problem for him or her:

1. Four-wire systems are an excellent means to avoid secondary neutral drop problems.
2. Grounds at the transformer pole and at all service entrances should be of a good quality and as close to 25 ohms or less as possible. Grounds on the secondary side should be separated by 1-1/2 to 2 times their length. Equipment must be adequately grounded.
3. 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.
4. Conductors should be adequately sized for the expected load.
5. Connections on the neutral system should be checked on an annual basis or as needed and split bolts replaced.
6. Equipment should be installed in accordance with local and state electrical codes.

Information as well as financial assistance programs to encourage farmers to adopt these practices should be provided by utilities. Good wiring and equipment practices on the secondary side are important and necessary steps to prevent stray voltage problems.

6. Isolation

Neutral isolation separates the primary and secondary neutrals in order to prevent off-farm sources of stray voltage either originating on the utility line or on a neighboring farm from accessing "cow contact" areas. It should also be recognized that neutral isolation reconfigures the circuit and as a result can "solve" (i.e., mask) on-farm problems in some situations. The Commission accepts that the multiple grounded system in which primary and secondary neutrals are solidly bonded is the preferred means by which to minimize primary neutral to earth voltages on rural distribution lines for both operational and safety reasons. However, neutral isolation can have a mitigative effect on stray voltage problems. Thus, while the Commission realizes that neutral isolation does not enhance the quality of the electrical system, it also realizes that the neutral isolator can be a valuable tool to combat off-farm sources of stray voltage.

The multiple grounded wye system is a commonly used distribution system which seeks to ensure safety against technical failures and lightning by the bonding of utility and customer grounds. It is not the intention of the Commission to encourage the use of neutral isolation except as necessary or where a safer solution is not available. Neutral isolation may be utilized as a stray voltage solution to gain time to correct the source of a stray voltage problem or as a longer term solution when the source cannot be found or easily corrected. When the source of the

problem is corrected, it is preferable that the isolator be removed.

For purposes of safety and proper operation, it is common practice (and sometimes required by the electrical code) for communications companies (telephone, cable television, etc.) to interconnect or bond the grounded elements of their facilities to specified power system grounds of the electric utility and service entrance grounds of customers. In these situations, a parallel path(s) between the electric utility's primary and secondary systems is provided that can defeat the isolation intended when the primary and secondary electric neutrals are separated for purposes of testing or limiting off-farm sources. It is important, therefore, that such parallel neutral/ground paths be investigated during stray voltage investigations.

Where it is necessary to also disconnect or interrupt this path for purposes of testing and/or installing or removing isolation, the communications company should be contacted to do any necessary work involving its facilities. Those electric and telephone utilities which have not already done so should develop and implement appropriate agreements, procedures and working arrangements between each other in their respective common service areas to provide necessary advance notice, coordination, and scheduling when mutual involvement and assistance is needed. Customers, electricians and other nonutility parties should also be advised that they should not disconnect, rearrange, work on, or

tamper with any utility (electric, telephone, gas, etc.) facilities without proper advance notice, assistance, or consent of the owning company. This instruction is necessary and will be made a part of the order herein so that the serving utilities can ensure that their facilities are not damaged by persons untrained in, and unfamiliar with, the installation and maintenance of utility facilities; that utility service to the farm being tested, as well as to other customers, is not unnecessarily disrupted; and that, after such testing or isolation, the serving utilities' facilities are restored in accordance with the technical and safety requirements of the serving utilities and the Wisconsin State Electrical Code.

The evidence in this docket indicates that isolation may raise the levels of primary neutral voltage on neighboring farms. However, this evidence also suggests that on a single isolation this effect is localized and can be neutralized by actions such as additional grounding. Therefore, the Commission should require that where a utility does not do so already, adequate measures be taken to ensure that isolation does not adversely affect neighboring farms. This would mean informing those farms when isolation has in fact resulted in increased primary neutral levels which cannot be reduced by available means. There is a concern that widespread use of isolation on the same line can create problems to a greater degree than a single isolation. Indeed, multiple isolations on the same line may be a good indicator of the need to upgrade or rebuild an existing distribution line. The

Commission will seek further information on the effect of multiple isolations on the same line and take further action as appropriate.

Finally, the Commission is also aware that the its determination that it is desirable to use isolation only when necessary, and as a temporary means to allow the source of the problem to be corrected, may conflict with some farmers' belief that isolators should be a permanent form of insurance. However, the more the use of neutral isolation increases the more likely that the integrity, adequacy, safety and reliability of the distribution system will be compromised. The Commission at this time believes that the solution to this problem is education and financial incentives which favor correction over mitigation, including isolation. This effort to use incentives to motivate behavior is preferable to the development of an absolute policy which denies a customer the ability to seek isolation when he or she deems it appropriate. We agree with those utilities which note that if farmers want to be isolated that there is the possibility that they may take far more dangerous actions on their own to become isolated if an isolator is not an option. However, should the incidence of isolation where there is not an underlying justification for such action increase to a level of concern, the Commission will be prepared to take actions which ensure the integrity of the existing system. The goal will be to limit the widespread or indiscriminate use of isolation.

Based on the foregoing reasons, the Commission will require

that all utilities file neutral isolation policies for Commission approval within 90 days which conform to the following guidelines, if those on file are not appropriate, or show cause why such guidelines should not be applied to them. The guidelines which follow are based on the formats used by Northern States Power Company and Wisconsin Public Service Corporation.

1. Isolators should be installed at no charge to the customer when the appropriate threshold levels are exceeded and the source is the primary neutral or an off-farm problem transported over the primary system.

2. The customer who receives the isolator at no charge should be informed that the isolators are temporary until the off-farm problem is corrected or until the farmer corrects the on-farm problem or installs an on-farm mitigation device.

3. After the off-farm problem is corrected, or where there are no off-farm problems to begin with, or where the threshold levels are not exceeded, the farmer should bear either an initial charge or a charge should be applied after some reasonable period of time is allowed to take corrective or mitigative action. A trial period at some initial nonrefundable amount, with an additional sum due after some period of time, would be reasonable.

4. Neutral isolation could be prohibited in the following circumstances:

(a) The removal of the farm grounds cause the primary neutral voltage to increase to unacceptable levels.

(b) The installation of the isolator causes the farm electrical system to be unsafe including because of lack of farm grounding.

5. Neutral isolation could be used only as a short-term, temporary measure in the following circumstances:

(a) An alternative mitigation device such as an equipotential plan is a more economical, safe and effective long-term solution.

(b) The off-farm problem is corrected.

We believe these isolation guidelines along with the provision of adequate information and financial assistance on available options will allow farmers to make informed choices and will provide a least cost solution to utilities. We expect these guidelines, as NSP notes, to encourage customers to compare the costs of the isolators with the costs and benefits of other corrective or mitigative action. Again, the Commission reiterates its intent to implement a policy which over time will encourage the correction of problems as the first course of action. This should lead to the ultimate removal of isolators when they are no longer needed.

The Commission in this investigation also was presented with evidence that there are operational differences between types of neutral isolators now in use. In a response to the Commission

questionnaire, Wisconsin Electric Power Company noted that saturable core isolators may not operate effectively in certain circumstances such as where there is inadequate grounding on a farm. Solid state switches do not have these problems. The Commission recognizes that the utilities are now only buying solid state switches. The Commission will require the utilities continuing to use saturable core isolators to ensure that they are installed in proper conditions and operate appropriately. The Commission will seek further information on the relative merits of saturable core versus solid state isolators and take whatever action may be appropriate as a result of that information.

7. Other Mitigation Techniques

The same principle that causes of stray voltage should be corrected rather than simply mitigated also applies to mitigation techniques other than isolation. Several types of mitigation techniques already available to customers and utilities can provide relief to stray voltage problems. Electronic Grounding Systems are expensive but, if competently installed, can suppress the amount of current accessing animals in the "cow contact" areas.

The most used mitigative technique is the equipotential plane which is required by DILHR Volume 2, State Electrical Code, to be installed in all new livestock facilities in Wisconsin. Equipotential planes are simply a grid of conductors buried in a concrete floor and bonded to the neutral of the electrical system.

The goal is to ensure that all of the metal which an animal may come into contact with are at the same voltage potential. While an equipotential plane can be an effective means to mitigate a stray voltage problem, the experts have noted three concerns. First, the areas which are planed must include waterers and feeders as well as the milking parlor floor. Second, a transition plane for animals to get on and off the plane may be necessary if the potential between the plane and the surrounding ground is great enough. Third, the effectiveness of equipotential planes may be affected by the electrical properties of the concrete floor.

As noted previously, the resistance of the floor is affected by the age and moisture content of the concrete, the thickness of the concrete and the type and moisture level of the soil in contact with the concrete. While planes can be retrofitted into existing facilities, these concerns are further reasons for all parties to concentrate on removing causes. Notwithstanding, equipotential planes can mitigate stray voltages or serve as additional insurance to ensure against future problems developing.

8. Information and Customer Complaint Procedures

The procedures which are used to explain stray voltage investigations to a customer are as important as the results of those investigations. If customers are to have confidence in the findings, they should have the opportunity, and indeed be encouraged, to participate in the investigation and be informed

why things are being done and what the results of tests mean. The utilities, in their responses to the Commission's questionnaire, appear to recognize the importance of good communications with the customer to both analyze and solve stray voltage concerns. In addition to these actions, the Commission finds that utilities should provide the results of its testing to the farmer, in written form if so requested.

The information submitted in this docket also indicates the importance of short response times to stray voltage complaints. The utilities have made good faith attempts to respond promptly. The Commission encourages the continuation of this attitude as well as one that emphasizes trying creative approaches when normal responses do not seem to have solved a problem.

Utilities should continue to provide information to customers on the symptoms which attach to stray voltage as well as on preventive, diagnostic and mitigative techniques which are available if stray voltage is a concern. Utilities should also continue or establish regular stray voltage related trade ally and farm information programs. In addition, encouraging all dairy customers to install a voltmeter in their facilities to monitor and signal potential problems is a useful action since both the on- and off-farm electrical system is exposed to changing environments. The Commission finds the utilities' continuing efforts to improve their information programs deserve recognition.

The Commission also finds that an easily understood, uniform presentation needs to be developed for educating the farm

community and others about stray voltage. While individual utility pamphlets or fliers are informative, the utilities and other interested parties should work with the Commission staff to develop a handout which uses easily understandable or defined terms in a common manner and which includes proven solutions that are available.

The Commission commends the utilities on their financial assistance programs for preventative or corrective actions to resolve on-farm problems. These programs which can develop as experience is gained will contribute to the economic health of the utilities' service territories as well as serve as effective inducements to the correction of problems rather than the use of isolation where it is not necessary on a long-term basis.

To ensure that the Commission is aware of customer service policies concerning stray voltage, the Commission will require the utilities to update the policies filed in this docket as they are changed.

9. REA 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 extremely helpful and involved with the proceedings in this docket as well as with the entire issue of stray voltage. As the representatives of the Wisconsin Electric Cooperatives Association have stated,

WECA has participated and intends to continue to follow the Commission's efforts in this area including the pursuit of the recommendations in this order. In developing its statement of general policy on stray voltage, the Commission has kept in mind that the electric cooperatives have indicated that they will follow the Commission's lead despite the absence of jurisdiction by trying to ensure that policies are simple, easy to implement and flexible enough to deal with specific utility situations. The Commission will also extend technical assistance as needed or desired by the cooperatives to detect or resolve stray voltage problems.

10. Stray Voltage Analysis Team (SVAT)

While the exact responsibilities of the new SVAT will be developed jointly by the Commission and the Department of Agriculture, Trade and Consumer Protection in consultation with the Stray Voltage Task Force, we feel that it is appropriate to identify the responsibilities that the Commission intends for its SVAT members to perform. These responsibilities include the following:

(a) Reviewing the planning, operation and maintenance of rural distribution systems to prevent and solve stray voltage problems;

(b) working with DILHR and electricians to ensure effective on-farm wiring and grounding practices;

(c) working as a team with the utilities, farmers, veterinarians, feed specialists and electricians to solve stray voltage problems or to resolve disputes;

(d) working with all parties affected by stray voltage problems, including bankers and insurers to ensure a good understanding of the problem and its consequences; and

(e) carrying out individual stray voltage investigations under the terms and conditions of the new state stray voltage program.

The SVAT will have the Commission's full support and hopefully all parties will act to make its difficult job a success.

11. Other Commission Actions

The Commission's jurisdiction is limited to the actions of the utilities under its jurisdiction. Nonetheless, the Commission believes that its efforts to help resolve stray voltage problems should extend beyond its formal jurisdiction. Many issues needing to be addressed have no established procedure or organized group of sufficient size to comprehensively address them. For example, the Commission believes that the training and/or state certification of rural electricians is an important matter which should be pursued. The possibility of some form of mediation in lieu of litigation is also an issue that should be explored. The ability to establish an effective farm wiring inspection program is another issue deserving more consideration. Because addressing these matters is necessary to adequately solve the stray voltage

problem, the Commission will work with all other parties including other government agencies and farmers to initiate and pursue solutions even if they are beyond its direct jurisdiction.

12. DC, EMF and Other Research

The Commission's investigation in this docket has primarily focused on 60 cycle ac shock as the cause of commonly experienced stray voltage problems. Dc voltage levels, according to the limited evidence presented in this case, need to substantially exceed the objectionable levels of ac voltage to be of concern. Such potential levels are usually associated with such facilities as gas pipelines or other structures using cathodic protection systems.

The impact of electromagnetic fields on livestock is currently being investigated and will be addressed by the Commission in its Advance Plan order in docket 05-EP-5. The Commission believes that it is important to distinguish between EMF and 60 cycle ac shock particularly since the latter is a solvable problem while the former is still being investigated to see if it is a problem.

The Commission does, however, conclude that it will seek further information on the effects of dc voltages and EMF on livestock. It will also encourage utilities to become active in locally controlled research projects which concentrate on true-to-life research of 60 cycle ac shock problems. The utilities should submit recommendations to the Commission on possible areas for

such further research. The Commission will continue to track research on dc voltages and EMF and will make adjustments in its policies as are appropriate.

This order does not presume to answer all of the questions about stray voltage. What it has tried to do is establish a set of guidelines and recommendations to help detect and resolve present stray voltage problems and to prevent new or future problems. Our concern is for these farmers who have experienced the problem and for those who might. We are also concerned that stray voltage not become a problem that farmers focus on to the exclusion of others. The standardized testing and diagnostic procedures, the Commission oversight of rural distribution lines and the guidelines for neutral isolation are intended to ensure that all farmers are treated fairly and given effective help in a timely manner. To ensure that we continue to move forward, the Commission will prepare a written annual report describing the progress that has been made starting from September 1, 1988. With the continued cooperation and good faith of all parties, the conflicts over stray voltage which have sometimes arisen will hopefully become things of the past and the problems experienced mainly reasons to maintain our vigilance in the future to avoid their reoccurrence.

Ultimate Findings of Fact

THE COMMISSION THEREFORE FINDS:

1. That stray voltages are low-level voltages present across points (for example, drinking cup to rear hooves) in which a current flow is produced when an animal simultaneously comes into contact with them.
2. That stray voltages can cause stress and behavioral problems in confined livestock that can result in production losses as well as physical and manageability problems. This can result in serious financial loss and psychological stress to a farmer and his or her family.
3. That stray voltages can be caused by sources either on- or off-farm. These sources can include utility equipment or the farmer's wiring or equipment.
4. That a level of concern above which corrective or mitigative action should be taken if production and behavioral problems exist is 1 milliamperes in the "cow contact" areas (i.e., milking, feeding and watering areas).
5. That most stray voltage problems can be detected and corrected or mitigated if proper screening and diagnostic tests and equipment are used, including the use of resistors to simulate the resistance of the path through the animal.
6. That the best means to avoid stray voltage problems is the proper planning, installation, operation and maintenance of both the electric utility's and the farmer's electrical systems and equipment.

7. That neutral isolation, by separating the primary and secondary bonds, can be an effective way to mitigate an off-farm stray voltage problem. However, neutral isolation because it affects the integrity of a multiple grounded electric system should only be used where it is safe and needed to allow time for the cause of the problem to be corrected.

8. That there are other means of mitigating stray voltage problems if installed properly such as the equipotential plane and the Electronic Grounding System.

9. That accurate information, education and financial assistance to construct and maintain proper electrical systems is a good means to ensure that stray voltage problems are prevented, minimized or resolved.

10. That more research is needed concerning the potential impacts of dc voltages or electromagnetic fields on confined livestock.

11. That three-phase, open delta services derived from two-phase three-wire distribution systems can cause excess primary neutral current which might access the "cow contact" areas.

Conclusion of Law

THE COMMISSION CONCLUDES:

That it has jurisdiction under ss. 196.03, 196.28, 196.37 and 196.39 to enter an amended order setting forth its general policies concerning stray voltage and electric utilities as defined in s. 196.01(5).

Order

THE COMMISSION HEREBY ORDERS for each electric utility subject to the Commission's jurisdiction which has a distribution system which serves dairy or other confined livestock farms:

1. That such electric utility shall continue or start to implement the techniques to prevent or minimize the possibility of stray voltage problems set forth on pages 16 to 18 of the Findings of Fact above, or show to the Commission within 90 days good cause why it should not implement one or more of those techniques.
2. That within 90 days each electric utility shall conform, or shall file, its tariff(s) on stray voltage/neutral isolation, if necessary, to be consistent with the guidelines and principles set forth on pp. 24 to 25 of the Findings of Fact above, or show to the Commission good cause why it should not do so.
3. That within 90 days each electric utility with three-phase open delta services to farms shall submit to the Commission its policies and plans to replace these service systems by rebuild or adding the fourth wire as set forth on p. 15 of the Findings of Fact above.
4. That within 90 days each electric utility shall ensure that its stray voltage screening and diagnostic procedures are consistent with those principles and guidelines set forth on pages 6-13 of the Findings of Fact above, or show to the Commission good cause why it should not do so.
5. That within 90 days Northern States Power Company-Wisconsin, Wisconsin Electric Power Company, Wisconsin Public

Service Corporation, Wisconsin Power & Light Company and Madison Gas & Electric Company shall submit to the Commission the following information, if it has not already done so:

- a. its policy for future increase of primary voltage levels through upgrades or rebuilds;
- b. its rural tree trimming policies;
- c. its policy as it pertains to primary underground systems including the grounding procedures for these systems;
- d. its policy on visual and/or more extensive inspections of rural distribution systems;
- e. its policy on testing neutral isolators to ensure that they are operating effectively;
- f. its policy for periodically checking phase load balance and criteria for rebalancing loads on three-phase lines.

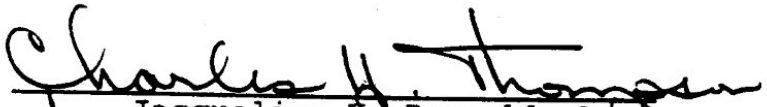
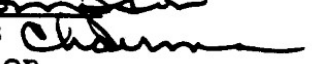
6. That within 90 days of the effective date of this amended order, those affected electric and telecommunications utilities subject to the Commission's jurisdiction shall develop and implement mutual agreements between their responsible offices and/or personnel in respective common services areas to provide assistance to modify their facilities when necessary to achieve isolation for testing or limiting off-farm sources of stray voltage. Such agreements should be consistent with the guidelines and principles set forth on pp. 21 and 22 of the Findings of Fact above. The detailed practices, procedures and responsibilities

Docket 05-EI-106

of the agreements should be set forth in writing and maintained as needed by the parties. They do not need to be (but may be) included or incorporated into the stray voltage tariff(s) previously filed in this docket. The affected utilities shall notify the Commission that such agreements have been executed and shall submit one copy as a sample of the agreements in effect.

Dated at Madison, Wisconsin, 8-10-89

By the Commission.


Jacqueline K. Reynolds 
Secretary to the Commission

JKR:GRE:erb01098905

See attached Notice of Appeal Rights.

Notice of Appeal Rights

To comply with the requirements of s. 227.48(2), Wis. Stats., notice is hereby given that a party aggrieved by the foregoing decision has the right and option to file a petition for rehearing as provided in s. 227.49, Wis. Stats., within 20 days of the date of mailing of this decision as shown on the first page. If there is no date on the first page, the date of mailing is the date indicated immediately above the signature line.

Notice is further given that a person aggrieved by the foregoing decision also has the right and option to file a petition for judicial review as provided in s. 227.53, Wis. Stats., within 30 days after the mailing of this decision. The Public Service Commission of Wisconsin shall be named as respondent in the petition for judicial review.

This general notification is for the purpose of ensuring compliance with s. 227.48(2), Wis. Stats., and does not constitute a conclusion or admission that any particular party is necessarily adversely affected or that any particular decision is final or appealable.

If this decision is an order after rehearing or reopening, a person aggrieved must seek judicial review rather than rehearing, if the person so desires. A second petition for rehearing is not an option.

BEFORE THE
PUBLIC SERVICE COMMISSION OF WISCONSIN

Investigation on the Commission's Own Motion)
into the Practices, Policies and Procedures) 05-EI-106
Concerning Stray Voltage for Electric)
Distribution Utilities in Wisconsin)

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(August 19, 1988)

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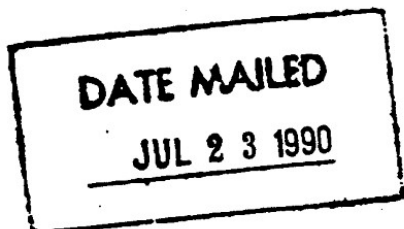
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COMPARED WITH AND CERTIFIED BY ME
TO BE A FULL, TRUE AND CORRECT COPY
OF THE ORIGINAL ON FILE IN MY OFFICE.

JUL 23 1990

Jacqueline K. Reynolds
Secretary to the Commission,
Public Service Commission of Wisconsin.

BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

Investigation on the Commission's Own)
Motion Into the Practices, Policies and) 05-EI-106
Procedures Concerning Stray Voltage for)
Electric Distribution Utilities in Wisconsin)

SUPPLEMENTAL FINDINGS OF FACT
AND ORDER

Background

On August 18, 1987, the Commission commenced a proceeding to gather information on stray voltage and its effects on dairy farms. During the Fall of 1987 and through April of 1988, public hearings were held around the state and in Madison to take testimony on the issues involved with stray voltage. The Commission's formal investigation culminated in its Findings of Fact, Conclusion of Law, and Order issued January 18, 1989. An amended order was issued in this docket on August 10, 1989, to incorporate some supplemental findings and requirements related to the involvement of communications utilities in coordinating with the electric utilities in the installation of neutral isolation. The remainder of the original order was unchanged.

As part of the order, each utility subject to the Commission's jurisdiction was required to file a stray voltage tariff including its policies, practices and requirements for installation of neutral isolation. The Rural Electric Cooperatives are not public utilities under Wisconsin Law, and since their rates and service

are not directly regulated by the Commission, they do not file tariffs with the Commission.

During the implementation of the tariffs, the Commission began receiving complaints regarding Wisconsin Electric Power Company's (WEPCO) neutral isolation practices. A dispute arose between WEPCO and staff regarding interpretation of the Commission's guidelines for the neutral isolation tariffs. The Commission decided that the difference between WEPCO's neutral isolation tariff and the guidelines in the original order warranted further formal investigation.

On November 24, 1989, the Commission issued a Notice of Limited Reopening and Prehearing Conference on Neutral Isolation Practices. A Prehearing Conference limited to the issue of neutral isolation tariffs was held on December 13, 1989, in Madison, for the purpose of defining the issues to be addressed and setting of schedules.

On February 26 and 27, 1990, public hearings were held before Examiner Donna Paske in Madison for the purpose of addressing the issues defined at the Prehearing Conference. Expert testimony was presented by the utilities, the Electromagnetic Research Foundation, Inc., and staff.

The parties, for purposes of review under sec. 227.53, Stats., are listed in Appendix A. Other persons who appeared are listed in the Commission files.

Findings of Fact

THE COMMISSION FINDS:

The neutral isolation guidelines defined in the previous order were intended to clearly establish the goals to be implemented by the utilities' tariffs. However, each utility applied and implemented the guidelines differently so that the end result was a set of tariffs that allowed for different treatment of customers based upon which utility was providing neutral isolation service.

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. If the utility system is causing stray voltage in the cow contact area greater than 1.0 milliamperes, it is not providing adequate service to that customer. Providing a system that does not cause stray voltage problems to the customer is to be considered basic service, not special needs.

Recognizing that different interpretations of the original order accounted for the divergence among the tariffs, staff and the parties to the Limited Reopening defined a set of issues that encompassed the areas of disagreement. These issues are:

1. The voltage at which neutral isolation is installed, i.e. whether the "threshold level" for installation of neutral isolation without charge to customers is the same as the "level of concern."
2. Isolation availability below the "level of concern."
3. When is isolation appropriate and when isn't it?

4. Who pays for isolation?
5. Who pays for other mitigation methods (i.e. on-farm mitigation)?
6. Isolation as a temporary mitigation measure. The appropriate time period to achieve or require other corrective action so the isolator can be removed.
7. Conditions for removal of existing and future isolation.
8. Uniformity of isolation tariffs.
9. Isolation agreements, excluding the liability waiver.

The Commission intends that the resolution of these issues should result in tariffs that conform to the guidelines and are uniform in application by all utilities.

1. Level of Concern and Threshold Level

The previous order's definition of "level of concern" is not changed. The "level of concern" above which corrective or mitigative action should be taken if production or behavioral problems exist is one milliamper steady state in the "cow contact" areas. This refers directly to Ultimate Finding of Fact No. 4 from the order of August 10, 1989.

In the August 10th order, a "threshold level" was established in order to define when neutral isolation would be installed at no cost to the customer. A misunderstanding arose about whether the "threshold level" and "level of concern" were equivalent. Different treatment resulting from different interpretations of the two levels has led to numerous inconsistencies in the various tariffs and complaints about how they were being applied. In order

to establish consistency among the tariffs, a clear definition is required.

The "threshold level" is equal to the "level of concern." When the "level of concern" is exceeded and the source is the primary neutral, neutral isolation shall be installed by the utility at no charge to the customer. All tariffs shall conform to this definition.

2. Isolation Availability Below the Level of Concern

The goal of the Commission to limit the widespread and indiscriminate use of neutral isolators and to implement a policy which will, over time, encourage the correction of problems as the first course of action has not changed since the previous order. Neutral isolation adversely affects the integrity of a multiple grounded electric system and therefore should not be a permanent mitigation device. The integrity, safety, adequacy and reliability of the distribution system should not be compromised. Based on the requirement for no-cost isolation, as described above, it is imperative that isolation only be used in cases where the level of concern is exceeded. Therefore isolation will not be used if the "level of concern" is not exceeded.

3. When Is Isolation Appropriate and When Isn't It?

When the level of concern is exceeded and the source is the primary neutral, then short-term, temporary neutral isolation is appropriate until the off-farm source is corrected or an on-farm mitigation device is installed. The utilities shall pay the cost of neutral isolation. In order for the utilities to have a

reasonable initial opportunity to identify and correct the problem, they shall be allowed five working days to do so prior to the installation of temporary isolation.

Neutral isolation is still not appropriate and may be refused or removed for the reasons defined in the previous order. Those are:

- a) The removal of the farm grounds causes the primary neutral voltage to increase to unacceptable levels.
- b) The installation of the isolator causes the farm electrical system to be unsafe because of lack of farm grounding.

4. Who Pays for Isolation?; and,

5. Who Pays for Other Mitigation Methods?

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, install 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 ratebase.

6. Time Period for Temporary Neutral Isolation

Temporary neutral isolation is to be allowed for a maximum period of 90 days. If more time is required due to extenuating circumstances, the staff will consider requests from the utilities, for a reasonable extension of time if appropriate justification is provided with the request. An extension of time for neutral isolation may be appropriate if unique or unusual corrective measures are required on the primary or for situations beyond the utility's control such as seasonal limitations to construction. A party aggrieved by any time extension allowed by staff may appeal to the Commission for review of staff's decision.

7. The Review of Existing Isolator Installations and Conditions for Removal

The Commission realizes that the amount of knowledge available today concerning testing methods, etc. for stray voltage is beyond that known just a few years ago. Also, the information is more accessible now. With that in mind, previous installations of neutral isolators may have been made based on reasons or criteria that today would not conform to the Commission's standards.

The utilities need to review the criteria and rationale for past isolator installations and develop a plan to remove, if necessary, previously installed neutral isolators that are no longer necessary based on current standards or changed circumstances. Each utility shall submit to the Commission, within

90 days, its plan and schedule to accomplish such a reevaluation and removal of unwarranted isolators. The plan should include cost estimates, the time required to complete the review, and proposed methods and timetables to accomplish removal in those cases where the neutral isolator is not justified or needed.

The Commission is aware that those customers who are presently isolated, for whatever reason, may be concerned about the potential removal under this revised policy. Those customers, however, should be assured that neutral isolators will not be removed without careful reevaluation and justification of need based on the Commission's standards for neutral isolation. Only after careful review to insure that a problem does not exist or has been corrected should isolators be removed. Customers who disagree with the proposed removal of isolator installations can request an independent review by SVAT through the normal SVAT review process.

8. Uniformity of Isolation Tariffs

Significant differences in the previously filed stray voltage tariffs of the various utilities and how they were administered and applied have raised serious questions of consistency and fairness. As a result, the Commission finds a strong need for a uniform tariff for all the utilities. The utilities are to present a suggested uniform tariff, in accordance with the Commission's present and prior findings and orders, within 30 days, for staff review. The utilities shall cooperate in developing this uniform

tariff. The Commission will review and approve or modify the suggested tariff as needed before accepting individual tariffs for filing and implementation.

9. Isolation Agreements

If isolation agreements are used and are included in the tariffs, they should be brief and clear, spelling out the terms and conditions for temporary isolation and the obligation of the utility and the customer while isolated. As previously directed, waivers of liability shall not be required as a condition of isolation.

Ultimate Findings of Fact

THE COMMISSION THEREFORE FINDS:

1. That customers with stray voltage are not "special needs" customers.

2. That the "level of concern" and the "threshold level" are equivalent. The "level of concern" is as defined in previous Ultimate Finding Fact 4, which states "that a 'level of concern' above which corrective or mitigative action should be taken if production and behavioral problems exist is one milliampere in the 'cow contact' areas (i.e. milking, feeding and watering areas)."

3. That the cost of temporary neutral isolation shall be borne by the utility if the "level of concern" is exceeded and the cause/source is the utility system.

4. That the cost, ownership, and maintenance of other mitigation devices shall be the responsibility of the utility if the "level of concern" is exceeded and the cause/source is the utility system.

5. That the utility may install these other mitigation devices on-farm, with the consent of the customer, and may include the installed cost in its ratebase.

6. That if the "level of concern" is not exceeded, the utilities shall not install neutral isolation.

7. That the time period for temporary neutral isolation shall normally be no longer than 90 days. Extensions of time may be requested for cause.

8. That the utilities shall cooperate in developing a draft uniform tariff within 30 days of the date of this order in compliance with this and prior orders in this docket for Commission review and approval.

9. That the utilities shall develop and submit a plan within 90 days for reviewing each of their present isolator installations. The plan shall include the information described in the Findings of Fact Item No. 7 above.

Conclusion of Law

THE COMMISSION CONCLUDES:

That it has jurisdiction under ss. 196.03, 196.28, 196.37 and 196.39 to enter a supplemental order setting forth its general policies concerning stray voltage for electric utilities under its jurisdiction.

Supplemental Order

THE COMMISSION HEREBY ORDERS for each electric utility subject to the Commission's jurisdiction which has a distribution system which serves dairy or other confined livestock farms:

1. That within 30 days, Wisconsin Electric Power Company, Wisconsin Power and Light Company, Northern States Power Company, Wisconsin Public Service Corporation, and Madison Gas and Electric Company shall collectively and cooperatively develop and submit a recommended draft uniform tariff on stray voltage/neutral isolation, in compliance with the guidelines and principles of the Findings of Fact and orders of this and prior Commission orders in this docket.

2. That for each other electric utility, they shall submit tariffs in compliance with the guidelines and principles of the Finding of Fact and orders of this and prior Commission orders in this docket.

3. That within 90 days, Wisconsin Electric Power Company, Wisconsin Power and Light Company, Northern States Power Company, and Wisconsin Public Service Corporation shall submit a plan for the review of present neutral isolator installations and a schedule for removal, if warranted, as set forth in the Findings of Fact Item No. 7.

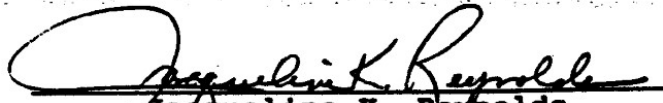
4. Except to the extent that this order directly supersedes any finding or requirement established by the Commission's order of August 10, 1989, all terms, conditions, findings, and requirements of that order remain in effect.

5. That jurisdiction is retained.

Dated at Madison, Wisconsin,

July 19, 1990

By the Commission.


Jacqueline K. Reynolds
Secretary to the Commission

JKR:LLS:06119007.erb

See attached Notice of Appeal Rights.

Notice of Appeal Rights

To comply with the requirements of s. 227.48(2), Wis. Stats., notice is hereby given that a party aggrieved by the foregoing decision has the right and option to file a petition for rehearing as provided in s. 227.49, Wis. Stats., within 20 days of the date of mailing of this decision as shown on the first page. If there is no date on the first page, the date of mailing is the date indicated immediately above the signature line.

Notice is further given that a person aggrieved by the foregoing decision also has the right and option to file a petition for judicial review as provided in s. 227.53, Wis. Stats., within 30 days after the mailing of this decision. The Public Service Commission of Wisconsin shall be named as respondent in the petition for judicial review.

This general notification is for the purpose of ensuring compliance with s. 227.48(2), Wis. Stats., and does not constitute a conclusion or admission that any particular party is necessarily adversely affected or that any particular decision is final or appealable.

If this decision is an order after rehearing or reopening, a person aggrieved must seek judicial review rather than rehearing, if the person so desires. A second petition for rehearing is not an option.

BEFORE THE
PUBLIC SERVICE COMMISSION OF WISCONSIN

Investigation on the Commission's Own Motion)
into the Practices, Policies and Procedures) 05-EI-106
Concerning Stray Voltage for Electric)
Distribution Utilities in Wisconsin

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(June 1, 1990)

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Cook
Exhibit # 451

Date: 3-10-99
H. Hammond

STATE OF WISCONSIN

CIRCUIT COURT

BROWN COUNTY

WISCONSIN PUBLIC SERVICE
CORPORATION,

Petitioner,

CASE NO.: 90CV-1130

vs.

PUBLIC SERVICE COMMISSION,

Respondent.

SETTLEMENT AGREEMENT AND RELEASE

This Settlement Agreement and Release is entered into by and between Petitioner, Wisconsin Public Service Corporation ("WPS"), and Respondent, Public Service Commission ("Commission"), and their respective counsel.

WHEREAS, Petitioner WPS has filed the above-captioned Petition for Review seeking review of the Commission's Order dated July 23, 1990 ("Order"), on the grounds that the Commission failed to follow proper procedure and that certain findings made by the Commission were contrary to the evidence and not supported by substantial evidence, and has requested that portions of the Order be stricken and the matter remanded to the Commission; and

WHEREAS, subsequent to the filing of the Petition for Review, the Commission issued its Order on Petition for Rehearing dated September 5, 1990, a copy of which is attached hereto as Exhibit A, in which it modified its Order dated July 23, 1990; and

WHEREAS, said modifications resolved some of the issues pending in this action; and

WHEREAS, Petitioner WPS and Respondent Commission are mutually interested in avoiding the further expense and delay connected with continuing the litigation herein and are mutually interested in amicably resolving any and all disputes remaining between them;

THEREFORE, it is agreed as follows:

1. The second full paragraph on page three (3) of the Order dated July 23, 1990, as modified by the Order on Petition for Rehearing dated September 5, 1990, provides as follows:

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. If the utility system is causing stray voltage in the cow contact area greater than 1.0 milliampere and the utility fails to mitigate the stray voltage problem in a manner required by this Order and the Commission's Order of August 10, 1989, the utility is not providing adequate service to that customer. Providing a system that does not cause stray voltage problems to the customer is to be considered basic service, not special needs.

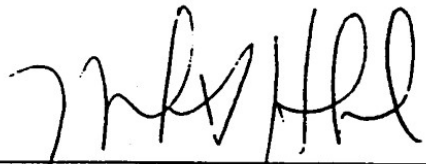
and was intended to be grounded upon and is grounded upon the utilities first being notified, or discovering, that a potential stray voltage problem exists and having a reasonable opportunity to investigate the matter and to correct any stray voltage problem caused by the utility system in a manner required by the Orders.

2. The agreement set forth in paragraph 1 above does not in any way affect or negate the utilities' obligations to

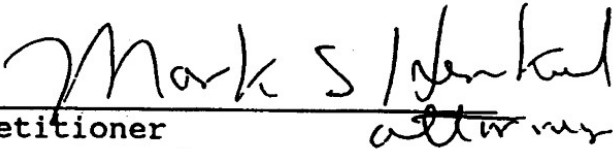
comply with any other legal requirements for the construction, operation or maintenance of their electric utility systems.

3. This Agreement is a full, final and complete settlement of the Petition for Review and the court may dismiss the Petition for Review on the merits and without costs to any party.

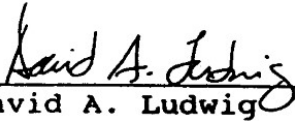
APPROVED AS TO FORM:

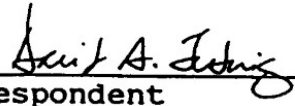

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Attorneys for Wisconsin Public
Service Corporation

WISCONSIN PUBLIC SERVICE
CORPORATION

BY: 
Petitioner
11/22/91
Date

PUBLIC SERVICE COMMISSION


David A. Ludwig
P. O. Box 7854
Madison, WI 53707
Counsel for
Public Service Commission

BY: 
Respondent
11/18/91
Date

DATE MAILED

SEP 7 1990



COMPLETED AND CERTIFIED BY ME
TO BE A FULL, TRUE AND CORRECT COPY
OF THE ORIGINAL ON FILE IN MY OFFICE

SEP 5 1990

Jaqueline K. Reynolds
Secretary to the Commission
Public Service Commission of Wisconsin

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-106

ORDER ON PETITION FOR REHEARING

Discussion

On January 18, 1989 the Commission issued its first order in this docket. The Commission subsequently amended this order on August 10, 1989 and on July 19, 1990 the Commission issued Supplemental Findings of Fact and Order. Four of the five named utilities, as well as the Wisconsin Electric Cooperative Association, petitioned the Commission either to reopen or rehear the matter. On August 21, 1990 the Commission issued a Stay Order, staying part of its Supplemental Order while it considered these petitions to reopen or rehear.

Section 227.49 (3), Stats., establishes the basis for granting petitions for rehearing. The statute provides:

227.49 (3) Rehearing will be granted only on the basis of:

- (a) Some material error of law.
- (b) Some material error of fact.
- (c) The discovery of new evidence sufficiently strong to reverse or modify the order, and which could not have been previously discovered by due diligence.

EXHIBIT A

SEP 10 1990

Section 196.39, Stats., authorizes the Commission to "reopen any case following the issuance of an order in the case, for any reason."

Findings of Fact

THE COMMISSION FINDS:

1. Its Supplemental Findings of Fact and Order did not include a material error of fact.
2. Petitioners did not present new evidence sufficiently strong to reverse or modify the order, which could not have been previously discovered by due diligence.
3. Petitioners have presented insufficient grounds to cause the Commission to reopen this docket.
4. The petitions do, however, reveal the Commission's intent was not clearly expressed in its Supplemental Findings of Fact and Order regarding adequacy of service. In particular, the relationship between adequacy of service and mitigation actions by utilities was not expressly set forth and needs to be clarified.

Conclusions of Law

THE COMMISSION CONCLUDES:

1. Its Supplemental Findings of Fact and Order did not include a material error of law.
2. Pursuant to ss. 196.02, 196.03, 196.37 and 227.49 (5), Stats., the Commission has authority to enter this Order, modifying its Supplemental Findings of Fact and Order to clarify its intent.

Order

THE COMMISSION HEREBY ORDERS:

1. The second full paragraph on page 3 of the Supplemental Findings of Fact and Order is deleted and replaced with the following text:

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. If the utility system is causing stray voltage in the cow contact area greater than 1.0 milliamperes and the utility fails to mitigate the stray voltage problem in a manner required by this Order and the Commission's Order of August 10, 1989, the utility is not providing adequate service to that customer. Providing a system that does not cause stray voltage problems to the customer is to be considered basic service, not special needs.

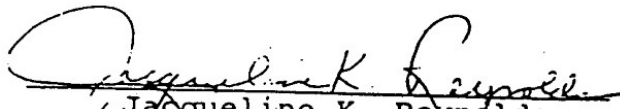
2. The petitions to reopen or rehear this case are denied.

3. As provided in Order paragraph 2 of the Stay Order issued on August 21, 1990, the named utilities shall file the required draft uniform tariff on stray voltage/neutral isolation within 15 days from the date this Order on Petition for Rehearing is mailed.

Dated at Madison, Wisconsin,

September 5, 1990

By the Commission.


Jacqueline K. Reynolds
Secretary to the Commission

See attached Notice of Appeal Rights.

D\05EI106

Notice of Appeal Rights

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