

Study Cites Cancer Incidence In Children Near Power Lines

By ELIZABETH KOLBERT

Special to The New York Times

ALBANY, July 8 — A study issued today by the New York State Health Department says that children with leukemia or brain cancer are more likely than healthy children to be living in homes where the exposure to the magnetic fields generated by electric power lines is high.

In addition to the higher incidence of childhood cancer, the study suggests that exposure to a magnetic field causes behavioral changes in laboratory animals.

Researchers were quick to note that they could not explain the higher incidence of cancer and that the study did not establish a direct cause-and-effect link. Other variables not measured by the study could be factors in the development of the disease.

"It is not obvious what a mechanism of inducing cancer might be," said Dr. David Carpenter, who oversaw the study. "That remains a major problem."

'Reason for Concern'

The study's findings "should not be cause for panic," said Dr. Carpenter, dean of the School of Public Health Sciences at the State University of New York at Albany. But he added that the conclusions "indicate some real reason for concern."

He said the study should prompt further research on the health effects of electromagnetic fields and could lead to standards for human exposure. Only in the Soviet Union, according to the study, do such standards currently exist.

The study combines the findings of 16 new research projects on the health effects of exposure to electromagnetic fields. It is the result of a decision by the State Public Service Commission, which ruled in 1978 that two high-voltage transmission lines could be built in upstate New York if a research program were established to study the associated health risks.

While the study was prompted by concern about the electric fields produced by high-voltage wires, greater risks of childhood cancer were found to be associated with the magnetic fields produced by wires carrying high currents. No correlation was found among adults.

High-voltage wires are used for transmitting electricity over long distances through rural areas. Ordinary transmission wires found in residential

neighborhoods may carry high currents if they are thick enough and close to power substations.

A total of \$5 million was contributed for the research program, called the New York State Powerlines Project, by the New York State Power Authority and the state's seven investor-owned utilities. These include Consolidated Edison and the Long Island Lighting Company.

Research contracts were awarded by a scientific advisory panel made up of experts in a variety of fields, including biochemistry, genetics, neurology and engineering. The panel screened applicants not only for their scientific expertise, but also for their lack of financial or professional conflicts of interest.

Dr. Carpenter said many of the scientists who participated in the project were surprised by the results. He said they had expected to find no correlation between exposure to electromagnetic fields and adverse health effects.

Household appliances also generate magnetic fields, but researchers found little correlation between the presence of appliances and the incidence of cancer.

Leonard Sagan, manager of the Radiation Sciences Program at the Electric Power Research Institute, said he had seen a copy of the Denver study in its preliminary form, but would not comment on it.

"It's not our study, so it's not appropriate for us to comment," he said. But the Institute, he said, was concerned about the possible health hazards associated with power lines and was conducting its own research in the area, including a study of cancer rates among electrical workers.

The Powerlines Project also found that there were some changes in the behavior of laboratory animals exposed to strong magnetic fields similar to those found along primary transmission lines. These include changes in biological rhythms and in response rates.

The study recommends "a major research effort on means of power delivery that would reduce magnetic field exposure." It concludes with the statement that "further research on the biological effects of electromagnetic fields is very important" and should be administered by a Federal agency "independent of partisan influence."

NYT 7/9/87

Savitz's Response

...I should first acknowledge that the array of available epidemiologic information is sufficiently incomplete and contradictory that further inspection of existing data is unlikely to resolve the issue. That is, the existing data are unfortunately incompatible with an array of views, including Dr. Cole's judgement that "there is no relationship between EMFs and cancer in human beings or if there is an effect it must be of very low magnitude."

Because I agree with much of what Dr. Cole has written, I will only focus on areas about which I would raise questions. In regard to my own data, I would question the legitimacy of declaring it negative based on a preponderance of risk ratios around the null value. One of the hazards of generating as many risk estimates as I did is the problem of making sense of the pattern. Although many individual risk estimates (e.g., for measured fields) suggest no effect, there are reasons to argue that the results from the analysis of wire codes reflect the best estimate available of long-term low-level magnetic field exposures in the home. If the "best" measure showed an effect and weaker measures showed weaker effects, this would be compatible with a causal relationship. The merits of the different exposure measures are open to debate, but the absence of effect for electric field measures and possibly even for magnetic field measures does not negate the potential importance of the wiring data.

The absence of a clear dose-response for the wire coding data is also acknowledged, but if one considers the relationship of average magnetic field to wire code, this could explain the lack of distinction among the lowest three levels (buried, VLCC, OLCC) and an increasing risk for OHCC and for VHCC, as was found. Part of the reason for no dose-response gradient might be the absence of a real gradient in exposure across the five wire code categories. The most substantial differences in risk corresponded to the most substantial differences in measured

magnetic fields related to the wire codes.

...Dr. Cole's suggestion that even supposedly "positive studies" are not entirely consistent prompted me to try to synthesize the information from just the childhood cancer studies (Warthimer & Loeper (1979), Fulton et al. (1980), Tomanius (1986), Coleman et al. (1985), Myers et al. (1985) and Savitz (unpublished)). I fully agree that there are inconsistencies even among the "positive" studies. The type of cancer showing the greatest effect varies markedly and the overall constellation of data does not all point in the same direction. Thus, the imperfect array of available data are consistent with the absence of a causal association as well as being consistent with a true, causal effect which has been clouded by methodological problems and random error.

The temporal trends and other aspects of existing literature are interpreted as indicating that a large effect of EMFs on cancer risk is unlikely, with which I also agree. Each line of evidence has a reasonable competitor to a causal interpretation, including the data from our own study. Nonetheless, the constellation of suggestive data is not easily dismissed in that postulating a true causal effect which has been diluted through poor exposure measurement can account for many (but by no means all) of the observations. The uncertainty in exposure identification pervades the literature, with most studies likely to be biased towards the null. I disagree with the assertion that "an effect must be of very low magnitude even among people who are moderately to heavily exposed" since we have yet to effectively isolate persons who have such levels of the relevant exposure.

It seems the most reasonable, unbiased reviewers of these studies come to the general conclusion that a causal effect of EMFs on human cancer has not been proven but that there are positive suggestions which should not be dismissed. There is less agreement on the more subtle questions of how close are we to proving causality, how compatible are the data with no causal association and how we should react to this uncertainty.

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Extension News & Views

Denzil Cooper, Extension Director
East Otter Tail County, Perham



STRAY VOLTAGE

Minnesota dairy farmers who installed neutral isolators to prevent stray voltage problems increased milk production by 700 pounds per cow over a 12-month period.

"With an average of 57 cows per herd, gross farm income was increased \$5000 a year," said Robert Appleman, dairy scientist with the University of Minnesota's Agricultural Experiment station. Cost of a neutral isolator is about \$500.

Appleman and co-workers studied 395 dairy farms in a four-county area. The farms had all installed neutral isolators by October 1986 to eliminate off-farm sources of stray voltage. And 84 farms had complete records available starting 24 months before the neutral isolators

were installed through 12 months following installation.

Average annual production increased from 15,300 pounds per cow immediately preceding installation to 16,008 a year later. After isolation, average milk production increased more rapidly than regional averages. However, there were no differences in mastitis, measured by SCC counts, or in reproduction performance as a result of the neutral isolators being installed.

"Isolation of the primary neutral from the farmstead's secondary neutral has become a commonly used

procedure for eliminating off-farm sources of stray voltage," Appleman said. Installation of the neutral isolators was generally limited to farms with voltages exceeding 1.0 volt at the barn service neutral at milking time; and to farms where screening tests determined that isolation would remove most of the voltage present.

Stray voltage can cause serious problems in dairy operations and other confinement livestock systems. Dairy farmers may lose production and experience cow behavior problems due to small electrical currents passing through the cows' bodies.

among children...then one might reasonably expect that during this century the childhood leukemia death rate would have risen more or less progressively...It is evident that power consumption has risen strikingly, there having been nearly a 100% increase in every decade. At the same time, leukemia mortality rates have shown a rise of about 40% per decade up to about 1950 and, typically, a decline thereafter...

These results for leukemia and CNS neoplasms, taken together, suggest that either there is no causal relationship between exposure to EMFs and these conditions in children or that, if there is any effect, it must be very small...Conclusions: The collective pattern of results that emerges from the epidemiologic reports is that of a weak, transitory effect that is not supported by consistent dose-response relationships or other internal characteristics of the data. A summation can only be that either there is no relationship between EMFs and cancer in human beings or if there is an effect it must be of very low magnitude even among people who are moderately to heavily exposed.

The above interpretation is fully supported by the absence of a temporal correlation between per capita electric power consumption and mortality rates of leukemia and CNS cancer among children in the United States.

Werthelmer's Response

...Dr. Cole seems to be reaching too hard to find explanations that deny the generally consistent positive findings of the studies. He says, for instance, that our study cannot be wrong because of chance or confounding, so it must be wrong because of bias; then, not believing that the Savitz results have the same problems with bias, he says they must be wrong because of uncooperative controls...Dr. Cole then recognizes that the major flaws of the occupational studies are unlikely to have produced the positive results found, so he concludes that those positive results are wrong because negative results were not published (though one must realize that powerful funding sources exist that welcome the finding and reporting of negative results), etc.

...I agree with Dr. Cole that it is particularly important to perceive the pattern of a number of epidemiological studies in evaluating a field. However, the strength of effect he looks for may be hard to attain for 60 Hz EMFs, because control groups will be universally exposed to this agent, diluting the risk ratios...

Responding to Dr. Cole's criticisms of our 1979 paper...He criticizes our method of data presentation. While our presentation was simple, I believe it was adequate (especially since Dr. Cole seems to have been able to compute the RRs and ARs he wanted from the data provided)....

Dr. Cole is skeptical about the similarity of risks seen for several different analyses. This is less surprising when one considers that the various analyses he refers to are simply different perspectives on the same basic data...

Finally, Dr. Cole suggests that since the Savitz study was superior to ours, Savitz should have gotten stronger, more consistent findings than we did. Actually, the differences between Savitz's results and ours (which are not so great) may have little to do with how well either study was done. The differences could be real: For instance, our work covered an era when young children usually stayed at home, but in the era Savitz covered children more often spent time at day-care centers, away from the home. Further, divorce, with division of the child's time between different homes, was probably more

common in the era Dr. Savitz covers. Both of these factors, by decreasing the time the child spent in the coded home, may well have weakened Dr. Savitz's results.

Concerning the Savitz study: Dr. Cole contends that the Savitz data show as many RRs under as over 1.0, and that therefore the study is null and fails to confirm our findings. However, many of the RRs (such as those relating to electric fields) that are under 1.0 were not intended to test our hypotheses. No one claimed they should be over 1.0...I don't myself think that counting RRs from non-independent tables is a very useful way to evaluate a study, but at least the results do seem to show that, no matter how one cuts the data, high-exposure homes generally have a greater cancer risk than low-exposure homes...

Concerning other studies cited by Dr. Cole: Dr. Cole discusses a number of studies linking cancer with occupational EMF exposures (although he omits an interesting study by Swardlow (1983), linking eye cancer (mostly melanoma) to electrical occupations...

I would agree that, in general, these studies cannot cast much light on our present problem because 50-60 Hz exposure cannot be assessed very well from occupational titles alone, and because, although "something seems to be going on," it may have to do with fumes and solvents rather than EMF exposure. However, my rough attempt to sort out probable exposures on the basis of job titles did not suggest that fumes and solvents are the whole story, or even the major part of the story.

I am concerned that Dr. Cole seems to put the most weight on what he sees as negative results from five RFUS studies (Vagerö (1983), Vagerö (1985), Olin (1985), Barregard (1985) and Törnqvist (1986)); yet each of these studies has either little convincing evidence of 50-60 Hz exposure, or little convincing evidence that the cancer rates were unaffected, or both...

In Tomerius's study only the 200+ kV lines were shown to produce excess exposure. For these power lines a significantly increased cancer risk of 2.1 was, in fact, seen...When...[I reworked his data], a positive dose-relationship with distance is seen...

The problems of the McDowall (1986) study are severe, for he provides no evidence whatever that his "exposed" homes actually do receive increased 50 Hz EMF exposure. In fact...there is little reason to expect such exposure...

Concerning Dr. Cole's contention that childhood cancer rates should have increased in this century if power lines were responsible for a fair share of childhood cancer: This is a naive assumption...There is actually little reason to suppose that exposure to 60 Hz EMFs has increased over the century simply because use of electricity has increased: High power use need not produce high EMFs.

As both the Savitz study and Kaune's work in Washington state showed, the EMF exposure at a house is not related to the total power use in that house. Furthermore, as power use has increased, technology has changed in a number of ways that reduce field exposure...

Perhaps most important is the clear finding of the Savitz study that buried distribution wires - a recent technology - generally produce less field in nearby homes than the old-fashioned overhead wires. In connection with this advent of buried wire construction, Dr. Cole's table of changes in the cancer rate of children from 1920-1980 actually fits nicely with the changes expected in EMFs produced in homes by power lines: The years when the old overhead wires were carrying more and more current (1920 into the 1960s) show increasing cancer rates, but these rates seem to have decreased since buried wires became common in the new suburbs...

all forms of cancer, both of children and of adults. This stretches credulity....

With regard to interpretation of the Wertheimer and Leeper (1979) report, there can be little doubt about the possibilities of chance and confounding. Neither of these two factors can explain the results at all. The consistency of the results obviates chance....Thus, we are left with the question, "Is the study biased or does it reflect causality or is there an element of both?" The answer is that it is biased. No other study approaches this one in strength or consistency of findings, despite better methodology....[T]he Savitz study must be regarded as generally superior and, perhaps, much superior. This is especially so for exposure assessment. This, in turn, should cause the Savitz study to be more strongly positive and the more consistent of the two. It is, unarguably, neither.

The Savitz Study (1986)...The [draft] Savitz study must be viewed as the definitive work, to date, on the question of EMF and cancer among children. Its only limitations are those put forward by Dr. Savitz himself: 1) it is somewhat small; 2) cooperation, especially of the controls, was deficient; and 3) results may pertain uniquely to the Denver setting. I consider only criticism number (2) to have...[valid] implications. I also believe that the analysis section is thorough...and the interpretation reasonable, even though it is not an interpretation that I wholly share. The further point that Dr. Savitz has advanced...that exposure measurement needs to be improved, perhaps goes without saying, but it is not clear that it could have been done better.

I consider the Savitz study to be an essentially null study and one that is, in any case, very different in its results from the Wertheimer and Leeper (1979) report. My opinion is based on three observations: 1) The amount of data generated and the number of RRs presented are enormous. Yet, there are nearly as many RRs below 1.0 as above.... 2) There is no consistent dose-response.... 3) A crucial age-effect is missing....

My interpretation is offered of the Savitz study: The results presented show a slight but inconsistent trend to the positive. There is no dose-response relationship and no internal consistency in the data. The study may be viewed as only suggestive of a weak effect. It argues strongly against any major or consistent effect. It is consistent with nullness.

Other Epidemiologic Studies...Most of these studies were done in an occupational setting and used industry or job title as an indicator of EMF exposures. However, four of the studies pertain to residential EMF exposures....This is not an exhaustive review....The proportionate mortality studies (PMRS) provide the most limited and potentially flawed data pertaining to cancer and EMFs, while (retrospective follow-up studies (RFUS)) are the most methodologically sound. The case-control studies (CCS) occupy an intermediate position. The residential studies are discussed separately.

PMRS...The six most pertinent studies [are Milham (1982), Wright (1983), Coleman (1983), McDowall (1983), Calle (1985) and Millman (1985)]....A diversity of occupations involving potential EMF exposures were considered in these studies and all subjects were assumed to have experienced such exposures. However, it is probably true that many of these workers were, in fact, exposed little or not at all....

The PMRS provide little or no evidence that EMF exposures are a cause of human leukemia. They are not convincing mainly because of the inherent limitations of a PMR....In summary, the PMRS are interpreted as, essentially, negative. **CCS**...[McDowall (1983), Pearce (1985), Lin (1985), Flodin (1986) and Stern (1986)] have a number of methodologic limitations for the purpose of evaluating the relationship be-

tween EMFs and cancer. For example, no direct measurements of EMFs were made in any of them and, with the exception of Lin's study, no attempt was made to evaluate dose-response. Furthermore, the men in these studies may have been exposed to other carcinogens which may explain their apparent excess of these cancers. Nonetheless, there is a clear tendency for positive findings in these studies. This is highly unlikely to be due to chance. It is also difficult to imagine how a bias or confounding by some factor could explain the consistent positive findings. However, a possible explanation of these positive findings is a propensity of investigators to report only positive results....

RFUS...None of the (five Swedish RFUS, Vagerö (1983), Vagerö (1985), Olin (1985), Barregard (1985) and Törnqvist (1986))...found an excess of leukemia and four of the five found no excess of cancer of the nervous system. The fifth study...[did].

The results of the RFUS clearly contradict the CCS. The RFUS also suffer limitations as do the CCS. For example, two of the studies were quite small and so do not provide persuasively negative results....However, on the whole, the methodology of these RFUS is better than that of the CCS. More importantly, these RFUS were designed specifically for the purpose of investigating the role of the EMFs in the etiology of cancer....For these reasons, considerably more weight should be placed on the results of the RFUS, than on the CCS....The occupational RFUS provide moderate or strong evidence that EMFs have no meaningful role in the etiology of cancer.

Residential Studies of EMFs and Cancer...Fulton (1980) conducted a CCS of childhood leukemia and residential wire configurations in Rhode Island. These investigators did not find a positive association....However, the validity of this study was challenged by Wertheimer. She claimed that the control distribution of residences was biased....The result of this bias would be to provide underestimates of the RRs. She re-analyzed a subset of Fulton's data, presumably correcting for this urban bias, and reported a statistically significant positive association. Fulton did not respond to her criticisms of his study. Thus, the findings and interpretation of Fulton's study are unclear and it must be considered a non-persuasive negative study.

Tomemius (1986) conducted a CCS of childhood cancer and EMFs in Sweden....An overall statistically significant RR of 1.4 was reported for all cancers....However...among the exposed, there is an inverse trend between distance of dwelling from the relevant electrical configuration and cancer risk. This observation argues against a causal interpretation of the weak overall positive finding.

Wertheimer and Leeper (1982) conducted a CCS of adult cancer in relation to residential wire configurations. They reported a strong and remarkably consistent positive association between overall cancer and EMFs....However, as in her study of childhood cancer, the coding of residential wire configurations was not done blinded and hence the positive findings may reflect observer bias. This study also suffers other limitations similar to those described above for her study of childhood cancer.

McDowall's (1986) RFUS [showed]...no overall excess of all cancer mortality, nor of leukemia....There was a slight, nonsignificant excess of lung cancer mortality. However, this could not be directly attributed to EMFs. A limitation of this study is that some of these people probably moved away from these residences subsequent to 1971, introducing a dilution of the outcome. Nonetheless, this is a sound epidemiologic study which provides additional evidence that exposure to EMFs is unrelated to the occurrence of human cancer.

New Information...[I]f it were true that EMFs cause leukemia

ve Corp., which provides electric-
y to Polley's farm.

Stray electricity from faulty
istribution lines is called "stray
oltage." Peterson said farmers
ith stray voltage usually could
olate the source of the electricity.
e he had seen other farms
it. y voltage, but they did not
ave high-power transmission lines
rossing them.

Kentucky Power spokesman
Tom Owen said company employ-
es inspected Polley's farm several
imes at Polley's request. Owen
said company engineers decided
he transmission lines were not at
fault, but that there was stray
voltage from Fleming-Mason
RECC's distribution lines.

Owen said the engineers rec-
ommended that Polley install a
neutral isolation device, which
would eliminate the stray voltage.
Owen said Kentucky Power offered

Polley the \$500 device for free, an
offer Polley refused because Ken-
tucky Power wanted him to sign a
waiver promising not to sue the
utility. Instead, he paid to have the
device installed.

Owen said Kentucky Power's
request that Polley sign the waiver
was not an attempt to buy him off.
He said the utility wanted to end its
involvement with Polley's problem.
"There are customers out there
that you provide something and
they want something else," Owen
said. "There's no end to it."

Owen said Kentucky Power
probably should not have gotten
involved in the case because Polley
is not a customer of the utility. He
said the utility got involved be-
cause it was "trying to do the right
thing."

Owen also said the utility want-
ed to show Polley the problem was
caused by Fleming-Mason's distri-
bution lines. Owen said Polley
should work with Fleming-Mason if
he had additional problems.

Polley said that since the neu-
tral isolation device was installed
six weeks ago, the herd's average
production had improved to 47
pounds. But he said the cows were
still nervous.

Jack Owens, operations super-
visor for Fleming-Mason, said a
check of the device this week
showed it was working properly.
Owens and M. Jack Fisher, an
engineer with the state Public
Service Commission, visited Pol-
ley's farm Monday.

Fisher watched as Polley and
Owens used different voltmeters to
measure electric charges around
the milking parlor. At one point,

Polley's meter measured three
volts, while Owens' meter showed
just one-tenth volt.

Fisher said both voltmeters
would be checked for accuracy.
But he was unsure what, if any-
thing, the PSC could do about
Polley's situation.

"We have no regulations of the
biological effects of electric volt-
age," Fisher said.

The highest reading Monday
came at a non-electric fence about
100 feet from the Kentucky Power
transmission lines. The fence regis-
tered 665 volts and gave visitors a
noticeable shock.

Fisher said cases like Polley's
were rare in Kentucky. But in
Wisconsin, one of the nation's lead-
ing dairy states, several stray volt-
age cases have led the Wisconsin
Department of Agriculture, Trade
and Consumer Protection to study
the problem.

Wisconsin farmers have filed
lawsuits over stray voltage. Polley
said he was considering a lawsuit
to recover his lost income.

"If they'd told me I was going
to go through this hell before I'd
bought the farm," said Polley, "I'd
have never bought it."

FROM THE FIELD

Epidemiological Evidence for an EMF-Cancer Link: An Exchange

Excerpted below is an edited and shortened version of An
epidemiologic Perspective on Electromagnetic Fields (EMFs)
and Cancer by Professor Philip Cole, chairman of the Depart-
ment of Epidemiology at the University of Alabama in
Birmingham, which was prepared for the state of Florida's Elec-
tric and Magnetic Field Advisory Panel (see MWN, March
April 1987). Drs. Nancy Wertheimer and David Savitz's respon-
ses to Cole have also been edited and shortened. Savitz revised
his comments before making them available to Microwaves
News.

Cole's Perspective

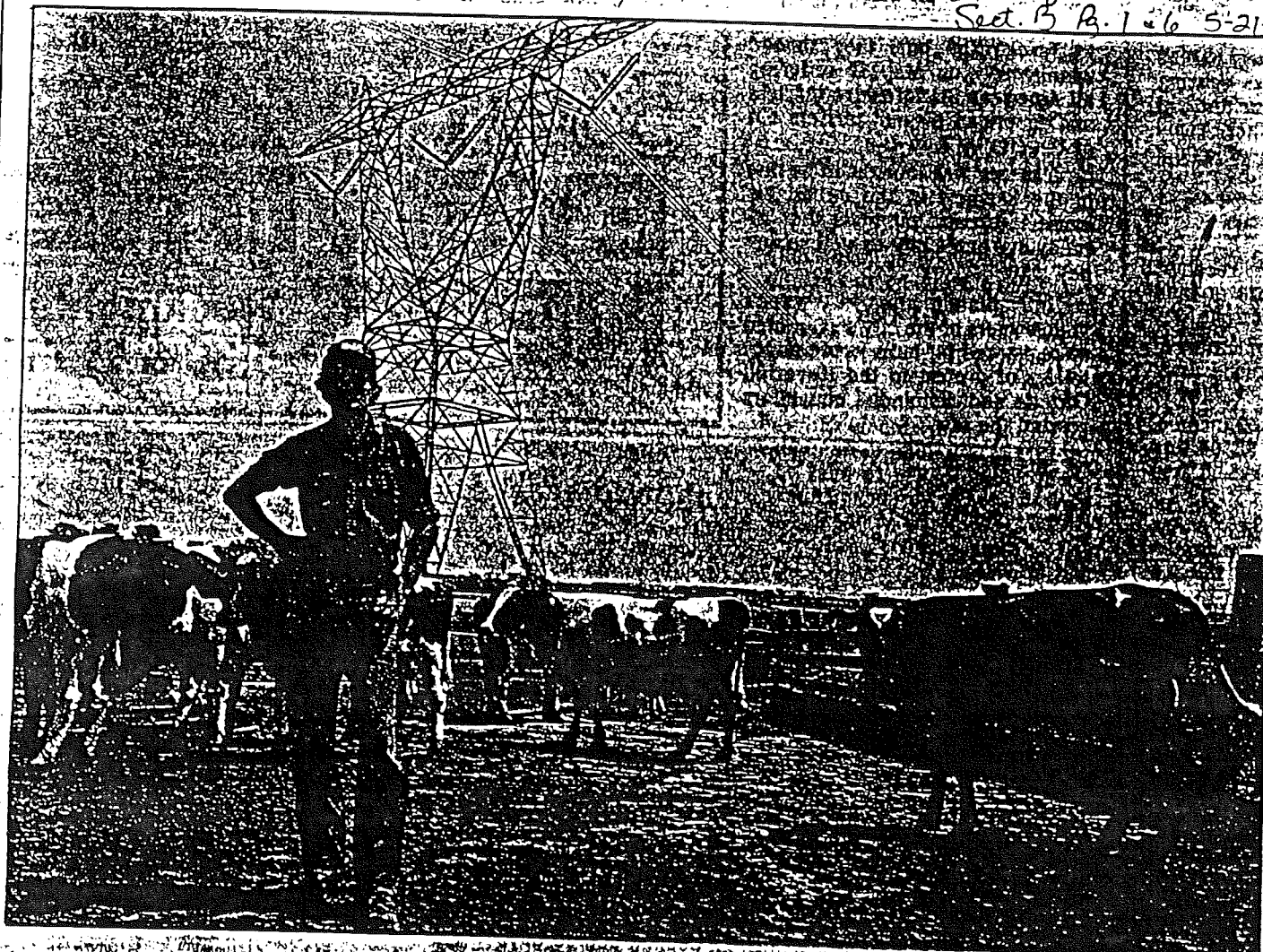
Wertheimer and Leeper (1979)—The paper brought to the
fore the question of EMF and cancer among children. The
paper represents that all forms of childhood cancer, but
especially leukemia, are increased about two- to three-fold
among children who are exposed to "high current"

configurations in their household wiring.

I was most struck by two aspects of the paper which I do not
believe have been mentioned by others and which cause me to
be unable to place confidence in it. The first is the complete
absence of the analytic machinery of epidemiology. Even the
primary associations are described only in terms of statistical
significance. There are no relative risks (RRs).

The second problem is what I can only term the paper's
"inordinate consistency." There are about 30 (not necessarily
independent) comparisons made. When these comparisons are
expressed in terms of RRs, they can be seen all (but one) to lie
in the range of 2.0 to 3.0.

Finally, the paper represents that the positive results pertain
to leukemia, to lymphoma and to nervous system and other
cancers of childhood. And Wertheimer has represented that
similar findings pertain to most forms of cancers of adults. In
short, it appears that Wertheimer proposes that she has
provided evidence that EMF increases considerably the risk of



A tower supporting 12 electric lines is in the middle of David Polley's Mason County dairy farm. Herald Leader, David Perry

Electricity troubles dairy farm

By Tom Daykin

Northeastern Kentucky bureau

RECTORVILLE — A visitor feels the stray electricity at David Polley's Mason County farm by touching a non-electric fence and receiving an electric shock.

Polley said he felt the stray electricity in his wallet. He estimated that he had lost \$100,000 in income since 1984 because his cows are nervous and producing less milk because of stray electric charges in metal farm buildings, fences and equipment.

Polley said his problems began in September 1984 when Kentucky Power Co. installed a 765,000-volt transmission network across northeastern Kentucky. The lines that cut through Polley's farm, two miles south of Rectorville, pass about 250 feet from his milking parlor.

The transmission network connects power stations in Ohio and Indiana. Large metal towers dot the countryside, and one stands in the middle of Polley's

farm, supporting 12 lines. Stray electric charges have made the cows nervous and made them produce less milk, costing Polley an estimated \$100,000.

farm, supporting 12 lines.

Polley said his 43 milking cows were producing a daily average of 51 pounds of milk each before the transmission lines were installed. He said the herd dropped to an average of 31 pounds after the lines began transmitting electricity.

Polley was alarmed and contacted Bill Peterson, Mason County extension agent. Peterson suggested changing the herd's feed.

"My feed bill tripled, but nothing happened," Polley said.

Peterson then advised Polley to im-

prove the herd's breeding program by selling some cows. Polley also rebuilt his milking parlor. But production remained low.

Polley said he heard last summer about stray electricity problems at other farms. He had noticed his cows were nervous, and he began looking at stray electricity as the cause.

Peterson and Larry Turner, an agricultural engineer at University of Kentucky, said they detected stray electric charges on Polley's farm. Turner said some charges measured more than a half volt, high enough to hurt milk production.

But Peterson said he was unsure about the electricity's source. He said the source could be electric equipment improperly grounded by Polley, Kentucky Power's transmission lines, or electric distribution lines owned by Fleming-Mason Rural Electric Coopera-

(Turn to **ELECTRICITY**, B6)

Becker Co. Record 4/13/87

Action begins on stray voltage problem

by James Campbell

For the Pesolas, Ahos and other farmers like them, there are some signs of hope.

Recognition of the problems they are facing is becoming more wide spread. Organizations are being formed and funding for research is beginning to emerge from the government.

U.S. Representative Arlan Stangeland (I-R — Barnesville) is working with Thelma Pesola of New York Mills in trying to resolve stray voltage problems.

Stangeland met with a group of farmers at the Winter Show at Crookston and pledged his support to them.

Stangeland said the farmers thought the Minnesota Department of Agriculture survey was too low so one of the first things they want to do is conduct another survey.

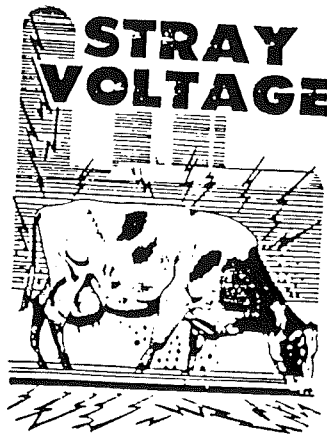
"We think there are a lot more people with problems," Stangeland said. "We're trying to find the magnitude of the problem."

Once that is done, Stangeland said the farmers hope to find money to conduct research to determine the problem's source.

"We know there's a problem out there. We don't know exactly what it is, what's causing it or what the solutions might be, but we hope to be able to find some of those answers," Stangeland said.

"In talking with people who are affected by it, it seems like quite a serious problem. I can't put an assessment on it, but they've got different assessments on the kind of damage that they're suffering."

"There's obviously a problem.



Some excellent dairy farmers a few years back have suffered some severe losses, and if they were excellent a few years back and nothing changed in their management style and all of a sudden they're in trouble because of loss of production and herd health, you know there's something other than just plain management."

Stangeland said, thus far, there has been no action toward funding research for the problem.

Minnesota has been researching stray voltage on its own for a few years now. The first money was distributed in 1985.

A total of \$65,000 was provided. Robert Gustafson of the University of Minnesota received \$37,500, and Duane Dahlberg of Concordia College received \$27,500.

The Minnesota Pollution Control Agency organized a committee to make recommendations to the MPCA board on the problem.

One of the recommendations was that the state Department of Agriculture conduct a survey

into the matter, which it did. (That survey was discussed elsewhere in this series.)

Funding efforts continue in the current legislative session. Rep. Rick Krueger (DFL — Staples) has introduced a bill that would provide \$150,000 to the state agriculture commissioner for a research study team.

According to Bobby Joe Hankey, an aid for Krueger, the team would "study problems of low livestock productivity and poor animal health."

"They took out the term stray voltage because a lot of people were having problems with it and they didn't want to limit it to just stray voltage," Hankey said.

"They wanted to solve the problems they were having and they're not sure it's just stray voltage," Hankey said, indicating that the study team is likely to also take a look at other sorts of electromagnetic effects that may be affecting animal health.

"They're just going to study what's happening," Hankey said. "Certainly if they could define it real clearly, they wouldn't need the study."

Senator James Pehler (DFL — St. Cloud) has introduced a companion measure to Krueger's bill in the Senate. Hankey said that both bills have passed their respective agriculture committees and are currently in the appropriations committees.

Hankey said both measures are likely to be passed if they can be brought to a vote before the end of the session.

"Right now, I think we've got it worked out so there isn't any opposition," Hankey said.

Professor explains impact of stray voltage

by James Campbell

Duane Dahlberg is familiar with the problems of stray voltage.

Dahlberg has a Ph.D. in physics and is a physics professor at Concordia College in Moorhead. He has been working on stray voltage problems the last several years.

He has also done research for the legislature on the problem. In the process, Dahlberg has worked with a number of farmers who have had problems attributed to stray voltage.

Through his work, Dahlberg is well versed with the conventional definition of stray voltage.

What has been referred to as stray voltage in the past has been the presence of alternating current, which has come from a short or fault, a wire on which the insulation is bare and touches the earth so electricity goes in the ground.

Or it's electrical energy that is on the neutral wire of a distribution line. The neutral wire is connected to ground all over, so if there is an A.C. potential on that wire, or any livestock would be exposed to it any time they touch the water cup or the water system because the pump is connected to ground.

The term has historically been applied to alternating

current that results from one of those two causes, a fault or A.C. potential to ground.

Dahlberg explains that with that understanding of the problem, the shock the cow would get when bridging areas of different electrical potential was thought to be the primary problem.

That was what they thought was affecting the cows, the shock. The cow might be touching the water cup which would be at a different potential than the feet. The feet would be on concrete so a current would go through them and they'd get a shock.

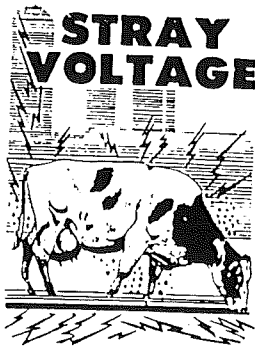
So, methods were developed to eliminate that difference in potential. Separation of power line neutrals from farm neutral through use of isolation transformers improved conditions on some farms.

But not on all farms.

What is interesting is that as researchers started correcting the problems by separating the neutrals

through isolation, they found that improved conditions in the barn, Dahlberg said. "But they also found cases they couldn't solve."

The next step, Dahlberg said, was to electrically tie everything in the barn together, thereby eliminating any possible difference in potential between the



various parts of the barn, eliminating any possibility of the cows being shocked. This solution is caused an equipotential plane.

If they were correct, that this whole problem is caused by the cows being shocked, that ought to take care of it.

But there were situations that solution didn't take care of either. According to Dahlberg, some of the farms he has visited that have created equipotential planes in the barn still have the same problems. "In some cases they're worse."

It was as a result of this sort of evidence that made Dahlberg

reconsider the accepted notions on the problem.

"What the farmers told me was that this is not a problem that the cows have when they touch the water cup, or the stallion, or something. It's a problem that the cows are experiencing all the time, it never goes away. It might be less or more, but it never goes away, the cows are constantly dealing with it," Dahlberg said.

"If one goes into a barn, where the problem is significant, all you have to do is look at the eyes of the cows and you know there is a problem because they're just bulging... You know they're stressed, you can just see it."

"And then when the milking machine is placed on them, that's an additional stress and sometimes they just go wild," Dahlberg said.

Dahlberg says he has seen a number of incidents of unusual behavior by cows that "don't make any sense from the standpoint of shock."

One of the most unusual reactions is when only portions of the udder can be milked.

And that cannot be explained in terms of the hormone (that causes milk to be let down) because that goes equally to all of the udder.

"The only explanation that I can imagine for that is that there is some physical thing that

causes them a pain or irritation or something when the milk goes down into the teat, so they don't want to let it down."

Dahlberg feels the key to that behavior lies in direct current that exists in the barn. He has experimentally changed the D.C. potential on the barn floor, which resulted in cows milking evenly.

Dahlberg has done other experiments on farms in an effort to learn more about the problem.

"So, we know that the milk let down can be related to electricity," Dahlberg says. "There could be other things, but we know it could be related to electricity."

"Milk let down is important because it can't be said that it's related to the food the cow gets, or the quality of water or how it's treated," Dahlberg says.

"In the work I've done, it appears to me that the basic problem is a D.C. buildup on the floor of the barn."

Dahlberg points out that all animals, including humans and cows, have bodies that operate through a multitude of electrical circuits at every level, so it is quite possible that a direct current buildup could effect those biological circuits over a period of time.

Dahlberg points out that he is talking about much smaller

direct currents than are currently thought to affect people or animals.

He says that in one experiment he did, a fraction of a micro amp caused a woman's arms to go numb after a few minutes of exposure.

He says that is the kind of power contained in a flashlight battery, and that while it may not affect everyone, it is clear to him that over time it is enough to affect some people.

In general, he says, women seem to be more sensitive to these effects than men.

Dahlberg admits the type of direct current fields he is referring to are hard to prove and difficult to measure.

He says the D.C. fields may be coming from a couple of sources. One may be the natural rectification of A.C. current in the ground.

"So if you have A.C. in ground you can have potential for rectification."

Dahlberg said another possible source for the direct current is from large power transmission lines.

"There's a certain amount of ground return that occurs, and where that goes, who knows," Dahlberg said.

The direct current fields can also build up naturally, Dahlberg said.

Dahlberg said that he is far from having a complete understanding of the issues he is raising, but he feels more research is needed to understand the things he has found.

"I feel what we're dealing with here is a very complex problem that means a lot of different things. But I do feel that the D.C. charge buildup in the floor is one of the main factors."

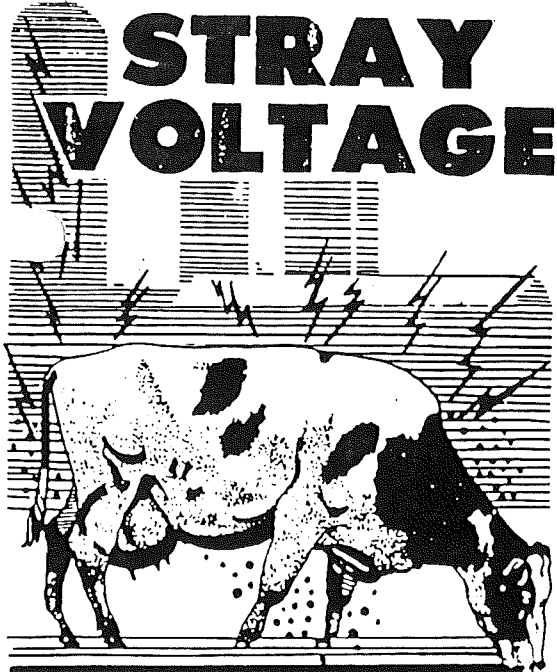
"I can't prove all that, all I can say is these are the correlations I find in working with the problem."

Dahlberg says that if what he has found is correct, then a solution to the problem would require the power suppliers to change the grounding system, a step that would be difficult and expensive.

Power companies don't give much credence to Dahlberg's work, but that's no surprise to

Dahlberg.

"If I'm right, they're in real trouble," Dahlberg said. "So they can't afford to agree with me."



Mysterious problem plagues dairy farmers

by James Campbell

(This is the first in a series of stories on stray voltage — a problem facing a number of dairy farmers in the state.)

Stray voltage.

If you're a dairy farmer, an electrician or otherwise familiar with the problem, it probably sounds more like something from a low-budget horror film than a very real problem to dairymen.

But despite the lack of public knowledge about the issue, stray voltage has been a nagging problem to dairy farmers for many years. It causes production loss and animal health problems that don't respond to conventional solutions.

The problem goes by many names — stray voltage, neutral-to-earth voltage, and tingle voltage are three of the main ones. What they are all referring to is, simply stated, an electrical voltage potential between the neutral (or ground) of an electrical system and the earth.

It can be a relatively common problem, arising from a number of different conditions both on and off the farm where it is manifested as a problem.

It can come from a short fault in a wire, a wire on which the insulation is bared or other similar situations both on and off the affected farm.

Or it can come to a farm on the neutral wire of a power

distribution line. That neutral wire is connected to ground all over the farm. Livestock could be exposed to the current through the equipment used in the dairy barn.

The wetness of a dairy barn and the heavy use of electrical equipment in dairy operations combine with the low electrical resistance of dairy cattle to make them especially susceptible to the problems it causes.

These problems can include lowered milk production, increased mastitis, longer milking times, uneven milkout, reduced feed intake, cows that are reluctant to drink water, and general nervousness among the cows along with other symptoms.

The problem has been around for a long time now, although lately it has begun to receive more attention.

It was first widely recognized about 30 to 40 years ago and has become more evident and more of a problem in the succeeding years as electrical mechanization has become more common on farms.

Much research has been done on the problem since it was first noticed. Relatively few undisputed conclusions have come out of the research.

Some research indicates that the problem of stray voltage is minimal and many of the problems attributed to it are the result of various types of poor farm management or poor animal handling practices. Other research indicates

that are not limited to dairy animal.

Through it all electrical suppliers have become familiar with installation of isolation transformers as a method of dealing with the problem when an other sources for it cannot be found.

In 1985, the Minnesota Legislature began funding research into the effects of stray voltage. As a result of that research, the Minnesota Department of Agriculture conducted a survey of representative dairy farms to generate data on the type, extent and impact of stray voltage problems in the state.

The survey questionnaire was hand delivered to Grade A and Manufacturing Grade farms around the state by MDA dairy sanitarians during routine inspections during the last half of last year.

About 8,000 surveys were distributed. About 1,100 were completed and returned.

While MDA officials readily admit that the results of the survey are not conclusive, they do say they show there is some sort of problem.

"There were 651 surveys that indicated no problem or that they felt their stray voltage problem had been corrected and for the most part answered 'no' to almost all of the questions.

"The farms which answered 'yes' to the problems most closely related to stray voltage problems numbered 251," the final report on the survey states.

The other group of dairymen which would appear to have some type of problem number 167. Through the survey, the sources of these farmers' problems are unclear.

The report on the survey states that farmers with problems are more likely to return the survey than those who have no problems.

Taking that factor into account, the report states that "even the most optimistic view would indicate that 5 percent of the 8,000 farms given survey forms (418 of 8,000) have some type of problem affecting the production of milk.

"If this figure of 5 percent is multiplied by the 20,000 dairy farms in Minnesota, there could be as many as 1,000 farms with production problems, many of which are related to stray voltage."

Many farmers and some researchers around the state have criticized that figure for being much too low. They say the Department of Agriculture

was far too conservative in its interpretation of the survey results.

Through different interpretation of the answers on the surveys, and by working with the number of surveys returned rather than the number distributed, they arrive at a figure of between 20 and 40 percent of Minnesota dairy farmers having stray voltage problems.

Because the farmers were required to put their names on the DOA survey, they say it is inaccurate to assume that everyone who had a problem returned the survey.

Some of them are attempting to secure funding from various sources to do more research on the problem.

Bill Coleman, director of the Dairy and Livestock Division of the Department of Agriculture, is the author of the final report on the survey. He said there were some flaws with the study, but he still felt there are still some conclusions that can be drawn from it.

"We certainly do have a number of farms with some type of problem, whether it's causing a loss of production or affecting the health of the herd in some other way," Coleman said.

But, he noted, "to tie that to stray voltage or some other electro-magnetic source is difficult to do."

That is the central issue in the problem. To simply say that the problem is stray voltage, there needs to be proof.

But, Coleman noted, "there are some that, by the way they answered the questions, definitely indicate that there is some type of electro-magnetic problem on their farm."

Coleman said that he felt, in some of those cases, the commonly accepted definition of stray voltage may not be adequate because some other electro-magnetic effect may be present.

Coleman said the Department of Agriculture has taken the position that the problem is real and is looking to find a solution.

"We feel there really is a problem out there," he said.

"What can be done about it, or how it should be done, is, I guess, the big question."

April 6
1987

Measure to study stray voltage OK'd

Forum 3/4/87

can be corrected if the voltage is measurable under guidelines set by the University of Minnesota study.

But on some farms, Graham said, an apparent phenomenon is occurring that cannot be measured.

Krueger said the legislation will provide money to study that problem. He expects the study to cost between \$100,000 and \$250,000, but the draft legislation he offered the subcommittee leaves the appropriation open.

A similar bill before the Senate contains only \$65,000 for the study, which Krueger says is not enough.

Also unresolved is what should be examined. The Senate bill calls for an examination of electro-magnetic fields, while the House version provides for a study of stray voltage.

John Sundvor
OTA EDITOR

ST. PAUL, Minn. — A loose-knit bill to once again study the effects of stray voltage on dairy production passed out of the dairy and livestock subcommittee Tuesday on its way to the House Agriculture Committee.

Drafted by Rep. Rick Krueger, DFL-Staples, the bill calls for a second examination of a problem the Legislature spent \$65,000 to study in 1984.

The first studies — one by the University of Minnesota and another by Duane Dahlberg, a professor of physics at Concordia College in Moorhead — raised as many questions as they answered, Krueger said. Farm groups — including the Farm Bureau — say the problem should be studied again.

Dairy farmers complain electric current is escaping from transmission lines, causing cattle to produce less milk and abort calves.

Bill Coleman of the Minnesota Department of Agriculture said a survey questionnaire asking about stray voltage was sent to 8,000 farmers between July and December. Of the 1,100 farmers who responded, he said, 650 said their cattle were not experiencing maladies brought on by stray electrical currents. He said 250 reported problems related to stray voltage and another 170 said their cattle were under some unknown stress.

Coleman believes about 1,000 farmers in Minnesota have ill cattle.

"There is definitely something wrong out there on those farms," he said.

Meanwhile, Ron Graham, lobbyist for Otter Tail Power Company of Fergus Falls, said the company toured about 600 Minnesota farms, many of them within 50 to 60 miles of Alexandria, trying to correct the problem. He said Otter Tail Power believes the problem

FARGO FORUM SAT MAR 14, 87 Minnesota House panel OKs study of dairy herd ailments

St. Paul, Minn. (AP)

A proposal for a \$150,000 study to investigate mysterious dairy herd ailments that some farmers believe are caused by low-level energy sources was approved Friday by the House Agriculture Committee.

The bill, sponsored by Rep. Rick Krueger, DFL-Staples, was passed on a voice vote and sent to the Appropriations Committee.

The problem is different than that caused by "stray voltage," which produces electrical shocks that cause animals to withhold milk, experts say.

But defining the problem was difficult for Robert J. Gustafson, a University of Minnesota agricultural engineering professor who tried to explain to committee members how the research would differ from previous stray voltage studies.

"I don't anticipate that we would find new phenomenon," Gustafson said.

However, he said the study would look at the combined effects of low-level energy sources and other factors, such as livestock feed.

Some of those low-level energy sources, which are undetected by humans, might stem from faulty wiring or breakdowns in insulation of certain farm equipment, Gustafson said.

Rep. Steve Dille, IR-Dassel, said he was skeptical about the source of the farmers' problems.

Dille, a veterinarian, said, "I can't help but think every unexplained problem that comes along on these farms is blamed on stray voltage."

He added: "I don't think it's some mysterious force in the environment that's not been identified."

After the hearing, farmer Marcene Hagen of Underwood in west-central Minnesota said she is tired of people suggesting the ailments were caused by poor management practices that they can't define.

"We can't register any AC voltage on our farm and yet we have these problems," she said.

For years, she and her husband, David, have noticed strange behavior in their cows. "Sometimes, they don't want to go back into the barn which is unusual because that's where they get fed and milked," Hagen said.

A neighbor who measures AC voltage on his farm doesn't encounter these problems with his herd, while the Hagens can't find any stray voltage yet have ailments so severe that they have had to sell dairy cows for slaughter, Mrs. Hagen said.

farmers fight ghost of 'stray voltage'

By Robert C. Bjorklund

Farm editor

Something is happening on Wisconsin dairy farms even more shocking than the continuing depression in the farm economy.

The shocker is "stray voltage" — sometimes constant, sometimes intermittent — usually low voltage — straying from where it should be.

At times, though, it may "spike" and send a shocking charge through the system.

If not controlled or corrected, the result is discomfort and infection of dairy cows and a costly loss in milk production that can threaten continued operation of a farm.

It always is difficult to find the causes, according to Bert Jones, a Wisconsin Power and Light Co. indus-

trial power engineer who works with farmers on the problem.

But, he said, causes include:

- Bad electrical connections on the primary lines bringing power to the farm.
- Flaws in the secondary lines on the farm.
- Poor grounding of farm equipment.
- Faulty equipment or improper wiring.

Craig Beane, and his son, Tom, Fort Atkinson dairy farmers, found

they were victims of stray voltage in their 200-cow operation after the profitable 16,500-pound milk production average of their cows slipped to 11,000 pounds and a loss.

Their voltage problem, now solved, was confirmed when they moved part of their herd to another farm and watched milk production climb.

The problem can mean stress and emotional problems for farmers who are baffled and frustrated because they can't see it, feel it, or, in some cases, even know the cause.

One of those troubled farmers is Howard Skjolaas, County Highway B, Elkhart. He has his mind made up he has stray voltage despite what WPL and sometimes conflicting findings by consultants.

"It's hairy and I'm scared. I don't know what to do. There must be a solution," he said. "I invite anyone to come and see if they can help."

Although stray voltage doesn't carry much of a charge, Skjolaas believes it could be part of the continuing problem he has with his total electrical system.

Points and coils will burn out in milking machine controls, barn cleaner controls, water pump, milk pump. He has a washtub full of seared

and melted electrical equipment he replaced.

He has a fair knowledge of electricity and he wired parts of the farm as consultants recommended. He admits he doesn't know what is happening when equipment burns out.

His problem is shared by others. The national cost of stray voltage, according to estimates by Michigan State researchers, is \$175 million a year — \$50 million in costs of replacement cattle and \$125 million in lost milk production.

Since Wisconsin produces 17 percent of the nation's milk, state losses could be more than \$21 million a year in milk alone. Cattle replacement costs add millions.

State Secretary of Agriculture Howard Richards is holding stray voltage meetings, first with affected farmers who want the state to form a stray voltage task force; then with utilities. Another is planned with electricians and farm equipment installers and a final one with researchers.

Richards conducts the meetings, he said, because he wants to know all the stray voltage issue before the department can help. He also wants to have information available for legislators who have interest in the issue.

Wisconsin has a state electrical code, but in most areas there is no inspection to enforce it. Milking systems and other electrical equipment on many farms are not wired according to code recommendations. There also are suggestions to license all

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electricians to meet state standards.

Electricians fear liability lawsuits. This has kept some from working with farmers on the voltage problem. Electricians would like the state to ban liability suits as they attempt to solve stray voltage problems.

Stray voltage traces back to advancing farm technology and added use of electrical equipment often installed on existing wiring systems.

Although stray voltages are usually low, cows are extremely sensitive and feel it before any farmer knows it's around. Research shows, and farmers agree, that some cows are unaffected. Cows ground stray voltage by touching steel equipment like stanchions, milking parlor stalls, milk pipelines and waterers.

Cattle subjected to these voltages are uneasy and often will do a weight-shifting "dance." Often they are reluctant to enter stanchions or a milking parlor in which they have felt the voltage. They eat and drink less.

Problems start when voltages in the cow-contact areas of barns and milking parlors are one-half a volt.

Electricians, meeting with Richards, said their biggest frustration was with transient voltage, which is voltage that moves to a problem farm from a neighboring source.

Stray voltage has been around Wisconsin since the 1970s and has been classified as a major problem since 1979. That's when technicians of the state Public Service Commission started getting complaints. A series of on-farm investigations was done by PSC electrical engineers to help farmers. About 50 farmers are on the complaint list now.

Lanny Smith, of the PSC's technical staff, said PSC work on farms is being reduced. He claims such work is not the commission's responsibility since its function is to check the utility only to the point farm wiring starts. Furthermore, he said, the agency has neither the manpower nor the resources to continue on-farm work.

Mark Cook, a Stoughton electrician, estimates 60 percent of the state's 40,000 dairy farmers have stray voltage problems. Other experts say it probably can be found on every farm, but for many farmers stray voltage is not a problem even if meters show it exists.

New grounding procedures for farm equipment have successfully reduced the effect of stray voltage.

Robert Otteson, a Stoughton-area dairyman and a Skjolaas neighbor, solved his voltage problems through a grounding system with the help of WPL. Now his only voltage problem recurs only when the electric motor on a corn drier starts on a nearby farm when his cows are being milked.

WPL worked closely with Skjolaas for years. There remains a strong difference of opinion between Skjolaas and the utility. Even though WPL engineers found no stray voltage, they kept working with Skjolaas. They worked to solve the problem hoping Skjolaas could become a satisfied customer.

The utility installed a grounding system, called an equipotential plane, in Skjolaas's milking parlor this year. To install the plane, grooves are cut into the concrete slab of the parlor, copper wire is laid into the grooves and all metal parts are bonded to a new ground system.

The system on the Skjolaas farm is one of 20 the utility has installed in stanchion barns and milking parlors in its distribution area to demonstrate one solution to the stray voltage prob-

lem.

But Skjolaas said the equipotential plane on his farm does not work. Cows, he said, continue to be uneasy. WPL said the equipotential plane on the Skjolaas farm was the only one they installed that received a negative rating.

Stephen Digman, a Monroe-area dairy farmer who installed such a system in his milking parlor, said the system solved his voltage problem.

Other farmers are paying for the installation of a system known as the Blackburn electronic grounding sys-

tem. This system has been successful, grounding all steel equipment and water systems on the farm.

Farmers can do something about stray voltage. They can have their milking system and milking procedures checked for the way they are managed and then consider installing either of the two grounding systems. That could cost \$2,000 up to \$4,000.

WPL is absorbing most of the costs of putting in demonstration units.

Other questions remain about the problem.

Is it always stray voltage that causes milk production and milk quality problems? Or do they also relate to farm and herd management?

Many stray voltage cases have entered the courts. The most recent one was in Waukesha County where two farmers filed a \$400,000 suit against the Wisconsin Electric Power Co.

The best-known stray voltage case was in Sheboygan County. Wallace Daggett, a Random Lake dairy farmer, received a \$1.1-million damage award from Wisconsin Electric

Power Co.

Voltage-affected cows no longer pay their way and are culled from herds and sold.

Skjolaas said he has had to ship 107 cows and said he is in the hamburger business.

He continues to milk only a token herd of 20 cows on the home farm where he once milked 100. His main milking operation with a 75-cow herd is on his other farm, operated by his son, Eric. The second Skjolaas farm seems to have no stray voltage problem.

INSIGHT / JANUARY 19, 1987

Udderly Traumatic

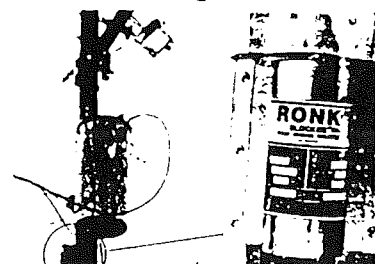
A jury in Polk County, Ore., awarded a farming couple \$90,200 cause inadequately grounded uterine lines sent electric shocks through couple's dairy herd and allegedly led to a reduction in milk production.

The case involved Perrydale residents Calvin and Dolly Haight, who sought damages from Portland Gen Electric Co. for harm to their herd of 100 Holsteins and Jerseys in 1982-1983. The couple claimed the uterine

lines caused shocks in the area where the cows were milked. Seven cows stopped producing milk, and the herd's milk production generally fell.

The \$90,200 represented the amount of damages the couple has requested. The Hights had asked the jury to look into the problem in 1981 but it was not until 1984 that the shock ceased — after the lines were grown in the farm's manure lagoon.

Stray voltage isolator



Designed to eliminate stray voltage originating off the farm, the Ronk Blocker is installed between the primary and secondary neutrals of service distribution transformer. It has low impedance for an abnormal voltage above 12 volts. The device operates on the principle of magnetic saturation and has no relays, sensitive components or wiring part damage. Contact: Ronk Electric Industries, Dept. TF, P.O. Box Nokomis, IL 62075.

Farmers fight ghost of 'stray voltage'

By Robert C. Bjorklund

Farm editor

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Other farmers are paying for the installation of a system known as the Blackburn electronic grounding sys-

tem. This system has been successful, grounding all steel equipment and water systems on the farm.

Farmers can do something about stray voltage. They can have their milking system and milking procedures checked for the way they are managed and then consider installing either of the two grounding systems. That could cost \$1,000 up to \$4,000.

WPL is absorbing most of the costs of putting in demonstration units.

Other questions remain about the problem.

Is it always stray voltage that causes milk production and milk quality problems? Or do they also relate to farm and herd management?

Many stray voltage cases have entered the courts. The most recent one was in Waukesha County where two farmers filed a \$400,000 suit against the Wisconsin Electric Power Co.

The best-known stray voltage case was in Sheboygan County. Wallace Daggett, a Random Lake dairy farmer, received a \$1.1-million damage award from Wisconsin Electric

Power Co.

Voltage-affected cows no longer pay their way and are culled from herds and sold.

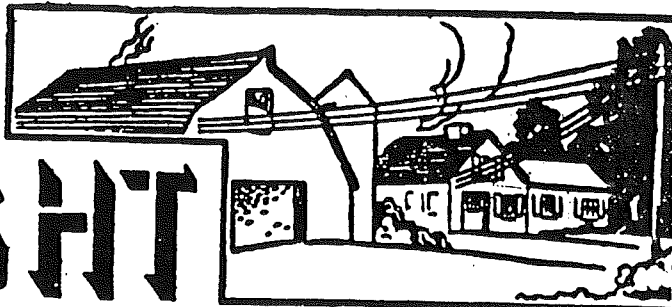
Skjolaas said he has had to ship 107 cows and said he is in the hamburger business.

He continues to milk only a token herd of 20 cows on the home farm where he once milked 100. His main milking operation with a 75-cow herd is on his other farm, operated by his son, Eric. The second Skjolaas farm seems to have no stray voltage problem.

Nov 16, 1986

"Owned By Those It Serves"

RURAL DE-LIGHT



WILD RICE ELECTRIC CO-OP., INC., MAHNOMEN, MINN. 56557

VOLUME 311 JULY 1985

Stray voltage: nature's nuisance to modern farming

The phenomenon making Elsie and Flossie kick, twitch and dance in the milking parlor could be the same thing causing the screen of your Apple, IBM or other home computer to blink. The phenomenon — stray voltage — is electric current wandering from its intended path (over wires or through the ground) through places of low resistance — a cow standing on a wet floor feeding from a metal bucket, or a computer system hooked up to faulty wiring in an old home.

Dairy farmers are familiar with the effects of stray voltage. Besides making cows jittery, the shock delivered by stray voltage can keep them from eating and drinking. It can also cause stress, which has been shown to contribute to decreased milk production.

Lawyers are becoming familiar with stray voltage, too. As farmers and others look for solutions to stray voltage problems, questions such as "Whose fault is it?" and "Who should be responsible for fixing it?" have come to the courts.

CAUSES

Stray voltage is nobody's "fault." It results from one of the

physical properties of electricity: electric current following the path of least resistance. Alternating current electrical systems are designed to allow current to return to its point of origin through "neutral" wires and through the ground. (This helps explain the technical term for stray voltage, neutral-to-earth voltage.)

Except under laboratory conditions, no electrical transmission system is 100 percent efficient or perfect. Some imperfections in an electrical system may allow current to be diverted through a source of even less resistance. Such imperfections on the system cause voltage levels on the neutral system and the ground to vary, sending a current through any source touching both of them. Thus, stray voltage is a natural condition resulting from current moving through the grounded neutral system.

What sort of system "imperfections" can cause excess neutral-to-earth voltage? The sources are limitless. Stray voltage could result from a bad electrical connection in a barn, use of too much equipment at once or improperly grounded machinery. The source doesn't have to be on your property, either. A grounding fault on the pump at your neighbor's house could create a stray voltage problem on your property.

As one expert points out, damp cobwebs on an service panel can retain electricity."

Regardless of where stray voltage originates, whether it is a poorly grounded pump down the road or bad wiring in your barn, it flows through everything that is grounded. This includes Elsie's stall, feeder, watering cup and other metallic things she comes in contact with. The cow actually acts as a bridge for current flowing from the voltage level of one spot, the wet ground beneath her, for example, to that of another, the metal feeder she has pushed her nose into.

Dairy farms are prime candidates for stray voltage troubles for several reasons. First, electric usage on dairy farms is high. Automation has brought machinery such as pipeline milkers and manure sweepers to the dairy farm, making the farmer and his business more dependent on electricity than ever before.

Added to that, cows are more sensitive to electrical current than humans. Studies show that milk cows may be as much as 50 times more sensitive to electric current than humans.

Stray voltage is not a concern only for dairy operations. Other farm animals, such as pigs, for example, have a low resistance to electrical current and can feel the effects of stray voltage. Computer systems and special equipment used in hospitals can also be affected by fluctuations in the electrical system.

SOLUTIONS

Stray voltage is inherent in all electrical systems. Although this excess neutral-to-earth voltage can't be completely eliminated, your rural electric co-op works to keep stray voltage problems to a minimum. Most of the homes and

Stray voltage

(Continued From Page 1)

businesses served by the co-op never encounter any effects of stray voltage. Farmers can take further measures to keep stray voltage low enough not to affect cows, other animals and equipment.

If you suspect that stray voltage may be a problem on your property, look for signs of an electrical problem. Do the lights dim when you start a motor? Do you feel a tingle or shock when using electrically-powered equipment? Is your electrical panel dirty and in poor condition? All of these are potential sources of stray voltage. You can use a voltmeter to pinpoint areas of varying voltage levels.

Be sure to work closely with your rural electric cooperative and your electrician to track the problem and solve it.

Dealing with stray voltage problems is the responsibility of the power supplier and the consumer. Your co-op is more than willing to coordinate efforts with you to reduce stray voltage and help keep Elsie, and the rest of the farm critters happy. (Penn Line.)

8537

Thursday, June 13, 1985

Farmers say the solution lies in banding together

"It appears that at least some of the DC is caused by re-actification of the AC traveling through the ground," Mugaas explained. "(Most reseachers) want to ignore DC."

While some people say they can feel the effects of stray voltage, cows may be as much as 50 times more sensitive to the electrical phenomena than people are, according to Ronald Gorewit, an agriculturure professor at Cornell University, Ithaca, N.Y. Cows that "dance" in the stantions, are reluctant to enter their stalls or the parlor, jump when they are touched and are reluctant to drink may be reacting to stray voltage.

In more serious cases, stray voltage can cause breed-back difficulties, swollen joints and multiple or recurring mastitis that doesn't respond to treatment.

"That's the biggest complaint is incomplete milkout and slow milkout," Mugaas said. "And if you don't sit there and get that milk out, your cows are going to get mastitis."

Lloyd Stender explained that because the milkout is uneven — it varies for each quarter of the udder — farmers often double their time and effort for each milking. Farmers can't just simply leave the milking machine on for longer periods since some quarters do milk out. And when they leave one milker unit on the cow for the slow quarter, she often become irritated and kicks it off.

University of Minnesota researchers began studying stray voltage in 1978. Their advice to farmers is that it can be corrected by proper management.

But the farmers at Hagen's farm said they've tried all the management suggestions, to no avail. And they say the problem increases over time.

Bruce and Sue Shol began working on the problem in 1981. They switched milking systems and spent nearly \$600 on an isolation transformer. They consulted veterinarians and university experts on feed rations. They've placed rubber mats under their cows.

But they still saw their milking time increase from three to five hours. Mastitis was so common, the vet was a frequent visitor and Bruce invested in his own treat

"Either we join together and come up with some money to help, or we go broke one at a time." — Milo Mugaas

separator to treat cows himself. The Shols opted for using a bull instead of artificial insemination, but breeding problems continued.

Recently, they've had some luck using steel plates to neutralize the field. But in order to make a profit, the Shols know they need to increase the size of their herd — a hard task when stray voltage shortens the cows' lifespans and causes breedback problems.

"That's the one thing about stray voltage, you don't see old herds," Shol said. The cows don't last long enough for farmers to develop a herd with selective breeding and culling.

Farmers feed cattle for two years before the first lactation. A cow is supposed to be in her prime by her third lactation. But farmers plagued by stray voltage say that's often when they must ship their cows. Incurable mastitis, failure to conceive or carry a calf to term and injuries from bad legs often mean an early slaughter.

The farmers said it's painful to watch their dairy cows suffer.

"If somebody would take a dog and treat them this way, the humane society would be all over them," Mugaas said.

The group has approached the humane society, as well as university researchers, power companies and politicians. While the initial interest was often high, they said, "within a week to ten days, they wanted nothing to do with us."

The farmers said stray voltage has been researched in Eastern Europe, Canada and Washington and occurs in dairy barns nationwide. A local seminar this winter drew about 200 farmers. They said it's likely the problem is more widespread than is realized and is growing.

"There's far too many, probably, that have it and

don't want to talk about it," Stender said. He said farmers who have accused others of scapegoating stray voltage for poor management have trouble admitting they have stray voltage when it happens to them.

And Carole Mugaas called it a "Catch 22" — farmers can't afford to stay in dairying, but they also can't sell their farm without warning the buyers they have stray voltage. She said attorneys have told them that they would be liable for any losses due to stray voltage if they don't warn buyers.

In most cases, farmers have had to pay the bills for equipment and professionals who have tried to help them with stray voltage. The group says if a solution to stray voltage is going to be found, it will have to come from farmers funding research.

"You know, farmers are funny. They'll spend \$10,000 for a new pipeline, but they won't give \$100 for research," Mugaas said. "But if farmers want anything done on this, they'll have to join together and fund this themselves."

Mugaas said the group hopes to raise \$50,000 to fund research headed by Duane Dahlberg, of Moorhead. Dahlberg, a former physics teacher at Concordia College and chairman of the Minnesota Pollution Control Agency, has already donated about eight months of his time to studying stray voltage. The farmers praised Dahlberg for his fresh approach, sensitivity and dedication in the light of opposition from other groups.

"The power companies know it's kind of a monster and they're just putting more locks on the door to keep it out," Mugaas said. "And farmers not affected by it now have the most to gain. Eventually it will affect everyone and it does get worse every year."

He added, "Either we join together and come up with some money to help, or we go broke one at a time."



Members of the stray voltage organization are Lloyd Stender, left, and Bruce Shol in front, and behind them from left to right, David Hagen, Sue Shol, Marci Hagen, Lynette Stender, and Carole and Milo Mugaas. The children are Mica and Bobbi Mugaas.

urnal photo by Coleen Neumann)

Stray voltage:

By COLEEN NEUMANN
Staff Writer

The sign at the driveway says "Hagen's Happy Holsteins." But, inside the barn, Hagen's Holsteins are anything but happy.

The dairy herd twitches nervously because of "stray voltage" — small currents of electricity passing through their bodies. It's a condition the owners blame for a drop in the herd's health, milk production and successful breeding.

Dave and Marci Hagen of Underwood first identified stray voltage as the culprit four years ago and have seen their once high-producing herd take a downslide ever since. Like other dairy farmers, they've grappled with understanding the phenomena and with seeking solutions.

Hagen and Milo Mugaas, a nearby farmer who sold his dairy herd because of stray voltage, are narrators for RSVP, Citizens Organized to Resolve Stray Voltage Problems. Formed this winter, the group is seeking incorporation for non-profit status and hopes to fund research on stray voltage. Recently, several of its members met at Hagen's farm to discuss the problem.

"Every one of us went through exactly the same rituals on our own," Mugaas said. "If we had all the money for things that have been tried to correct this, we'd have millions of dollars."

Stray voltage is also called neutral-to-earth voltage. The farmers said it often occurs in new dairy barns which are wired to code and have "green" cement.

Care is used to ground electrical equipment, but any grounded neutral network has some resistance to the flow of electric current. Due to these resistances, whenever there is a current in the neutral system, a voltage exists between it and the earth.

Early research centered around measuring AC voltage, but the farmers said the problem they've had in common is a charge build-up of DC voltage. Therefore, isolation transformers used to correct the AC voltage temporarily corrected their problem but didn't solve them.

Stray voltage progress made

by James Campbell

Slowly but surely, progress is being made toward solving the problem of stray voltage on dairy farms.

Stray voltage is an electrical condition that has been linked with production and health problems in livestock. It is most often a problem on dairy farms because of the damp conditions that are often present, and because of the high susceptibility of dairy cattle to the problems it seems to cause.

During the last session of the Minnesota Legislature, a bill was passed that formed a board to look at the problem.

Dr. Duane Dahlberg, physics professor at Concordia College in Moorhead, who has done research into stray voltage problems in the past, is one of the members of the board.

Dahlberg said the board has nine members. There are four farmers on the board, two who presently have problems with stray voltage, one who has had a stray voltage problem which is now solved, and one who has never had a stray voltage problem.

Others on the board include a representative from a private utility, a representative from a public utility, a vet., a representative from the University of Minnesota and a representative from the Minnesota Pollution Control Agency Board (Dahlberg).

Dahlberg explained that the members of the board were appointed by the Governor to oversee what will be done with \$50,000 the legislature appropriated for research into the problem.

Dahlberg said the appropriation should have been \$250,000, but last-minute cutting resulted in the appropriation being severely cut.

The board held the first of its twice-monthly meetings in September, and Dahlberg said they are just now beginning to get to the point where they are making progress on the problem.

"We are in agreement now on

What will be "done" is research. The board plans to have a research team look at the data that has been collected by one particular farmer near St. Cloud who has kept exhaustive records on his stray voltage problems and taken experimental steps to solve them.

The research will also take thorough measurements on a farm over a long period of time, and probably also take less thorough measurements on a few other farms, all in an effort to find out more about the problem.

Dahlberg says the legislation that created the board directs it to look into the problems of poor livestock productivity and health, with clear direction to examine the electrical sides of those problems, although they may also possibly examine management correlations with those problems.

Dahlberg said the legislation also directs the board to not repeat any of the research that has already been done on the problem.

By the end of January, the board should be able to make a recommendation to the Commissioner of Agriculture on who should be hired to do the research. The actual research could then start as early as February.

Dahlberg said the board is funded for one year, so the board should have results to take to the legislature in time for the 1989 session. At that time they will likely ask for continued funding on the basis of what is found in the research.

While Dahlberg is optimistic about what can be learned through research, he is also realistic.

"In research, one never says anything for sure because it depends upon getting a few breaks and getting the right farm that will show the changes that are needed," he said. "That's not always easy."

But, he said that just the compiling of existing information on the problem should be quite valuable.

Farmers face invisible villain as stray voltage harms cows

By ELIZABETH CULOTTA
of The Journal staff

When Wally Daggett's dairy cows take a drink, they may receive small electric shocks.

Excess electricity called stray voltage finds its way into metal drinking cups and milking equipment at Daggett's dairy farm near Random Lake. The stray voltage has caused his 200 dairy cows to become nervous, drink too little water and even develop bleeding ulcers and udder infections.

Daggett received more than \$1 million from Wisconsin Electric Power Co. in a 1984 judgment after filing suit in Sheboygan County. Since then, a handful of other dairy farmers have sued the utility over stray voltage and won, or settled out-of-court for substantial sums.

And for the first time, the state budget passed by the Legislature Thursday includes \$188,800 to educate farmers about stray voltage, said a spokesman for the amendment's sponsor, Rep. Barbara Gromelus (D-Buffalo).

The problem is that utility wiring systems were designed for humans, and cows can feel lower levels of electricity than humans can, said Ron Legro, public information officer for Wisconsin Electric. "It's a real problem for us," he said, "frustrating, subtle and hard to detect."

Stray voltage on a farm can mean decreased milk production, loss of stock and economic hardship for farmers. Hundreds or even thousands of Wisconsin dairy farmers may have the mysterious problem, according to officials of the State Department of Agriculture, Trade and Consumer Protection.

At this point, no one knows how much production is lost because of stray voltage, how many farms are affected, or how much it might cost to keep electricity away from cows.

Up to 25% of milk production may be lost on an afflicted farm, according to Bob Ehert, executive assistant at the agriculture department.

To protect prize-winning cows brought to the State Fair in August, concerned state officials have ordered inspections of electric wiring to detect any stray voltage at State Fair Park in West Allis.

Stray voltage is found "everywhere there is electricity," said James Prothero, an engineer with Wisconsin Electric. The excess voltage is the normal consequence of moving electricity through power lines, he said.

Ironically, the electricity gets to the cows because of a safety feature

explained Robert Appleman of the department of agricultural engineering at the University of Minnesota. Small amounts of electricity normally bleed off high-voltage lines or electrical equipment into grounding wires designed to carry excess electricity. For safety in case of lightning or short circuits, the grounding wires are hooked into the cow's motorized milking equipment and metal drinking cups.

Stray voltage becomes a problem when extra current surges along grounding wires, seeking the path of least resistance — often a cow. A variety of poor wiring conditions on a farm or in utility power lines may send electricity coursing into a barn, utility officials say.

However, farms plagued by stray voltage often are served by power lines identical to those of farms without stray voltage problems, according to Wisconsin Electric's Legro. Engineers also do not understand why certain areas, like Random Lake, are hotbeds of stray voltage. "From the utility's point of view, there's no difference there," Legro said.

When cows receive small shocks from their drinking cups or milking equipment, they may drink less and they may give less milk. After steady exposure to stray voltage for six months, chronic udder infections may mean that a "cow will never make money again [and] you might as well sell her," Daggett said.

Exactly how much stray voltage is too much for a cow is unknown; anything from one-half to two volts or more may be considered dangerous, according to farmers and state officials. Humans can feel electricity at about four volts.

Pigs are even more susceptible to voltage than cows are, Legro said, but pigs generally do not touch metal objects in the barn. So most complaints have come from dairy farmers, he said.

To tackle the problem, the agriculture department last year created a Stray Voltage Task Force composed of farmers, including Daggett; utility officials; and representatives of the agriculture department and the state's Public Service Commission.

The combined task force created a Stray Voltage Attack Team to research the problem. Ten Wisconsin dairy farms were chosen as research sites to explore sources, solutions and preventive measures. More than 100 farmers volunteered to work with the team.

Their research report, due in early August, will offer strategies to combat stray voltage and suggest who should pay the costs, according to PSC member George Edgar.

Remedies for stray voltage vary widely in cost and sophistication. To install a sheet of metal across the entire barn floor to prevent electricity from traveling through cows costs about \$5,000, a small sum compared with the cost of milk production and stock losses, Daggett said. But to replace two miles of power line, Wisconsin Electric must spend more than \$50,000. Wisconsin Electric representatives declined to reveal how much it will cost the utility to replace the entire distribution line to Daggett's farm.

Although stray voltage can be reduced, it cannot be eliminated, utility officials emphasize. When fighting stray voltage, "You can't do it once and wash your hands of it. You have to keep monitoring," agreed Ehert of the agriculture department.

Daggett thinks that 95% of stray voltage problems can be overcome. But he says that even after installing \$7,500 worth of new electrical equipment, he lost 23 cows to stray voltage last spring. Wisconsin Electric crews work at his farm "just about every week now," trying to rid his barn of stray voltage.

voltage can often move from one farm to another, through the ground or through the water table, and cause problems on a farm that is not its source.

If stray voltage is eventually determined to be coming to the farm through the power line, then an isolation transformer is installed.

The farmer is not charged for the tests, although a farmer will often have some of the work done by his own electrician.

If an isolation transformer is installed, the farmer is only charged the co-op's costs to put in the transformer. All isolation transformers are installed on a six-month trial basis. If the farmer feels the device has not helped after six months, it is removed and he is not charged.

However, there will probably be costs for a private electrician involved because additional grounding and wiring work is often needed.

"We don't charge the farmer for this, but we only do it in those cases where we have definite proof that the voltage is an off-farm type of thing," Markert said.

But isolation isn't a cure-all for stray voltage problems. Markert says wiring that is done incorrectly, or other sources, can bring about a return of the problem.

"Just because it's isolated we cannot forget it, because something else can happen."

Markert notes that Wild Rice is not the only possible source of stray voltage in the area the cooperative serves. There are also two other co-ops, three telephone companies, other independent power generators and possible natural earth voltages.

"It's a combination of many things, and even mother nature puts electric current in the ground," Markert said.

It is that multitude of possible sources that makes it useless to try to determine blame for the problem, Markert said.

"You really can't put the blame on anybody. Say you find a bad water pump on some farm five miles away. It is that guy's fault that the water pump is bad?

behavior problem as a result of the electricity on the farm."

He says Lake Region Power crews have tested a number of farms for stray voltage over the last few years. While some of those farms have had stray voltage that seems to have contributed to production problems, they also found some farms that had production problems that didn't seem to be related to stray voltage.

And they also found farms with significant stray voltages where there were no production problems.

"Stray voltage can be a problem...but on a scale of one to ten maybe the stray voltage in a given situation will only be a quarter of it or a tenth of it or zero," Peterson said.

He adds that stray voltage isn't the only cause of the symptoms some dairy farmers see.

"All these symptoms and problems that have come to pass — mastitis, breeding problems, retention of placentas, abortions, just to name a few — may have a whole host of other reasons."

He adds that stray voltage seems to be something in which no two farms have the exact same problem or solution.

"It's a case by case situation. Even the behavior of the dairy husbandry man or the farmer doing the milking can have a significant effect on the behavior of the animals."

"If to get control of the cow, you go up and twist the tail and damn near break it, you're going to get a reaction from the cow."

"I'm not trying to duck stray voltage, but there's all these other things. How do you deal with all the other things when everybody's focusing on the one thing?"

Peterson says that Lake Region is not trying to avoid the issue but merely trying to point out that there are other factors involved. When stray voltage on a farm is found to be a problem, he says Lake Region can take care of it.

"If the neutral to earth voltage problem is such that it is the cause of a drop in production, then it can be found and minimized or mitigated if you

Region crews will generally leave their testing equipment on a farm through two milkings.

But in many cases stray voltage seems to be a here today, gone tomorrow type of problem.

Because of that, farmers sometimes accuse them of not conducting an accurate test, but company officials say that while other testers have found stray voltage where they tested and not found any, they have also run tests and found stray voltage where other tests have not.

Peterson says that the problem is complicated by the fact that if a herd has a stray voltage problem, all of the herd health conditions and other symptoms of the problem aren't going to disappear overnight as soon as the problem is corrected.

The policies Lake Region has for dealing with stray voltage on farms are quite similar to those used by Wild Rice. Testing is provided free of charge and if isolation is called for, it is done at cost.

Peterson explains that isolation is not free because the co-op feels that it is a special, unique requirement of the farms that is not required by most of the co-operatives 19,000 customers.

Peterson said that if isolation makes a difference in a farmer's problem, it will pay for itself in short order.

Through it all, Peterson points out that stray voltage is a complex problem, one that is sometimes made worse by having things that it is not responsible for blamed on it.

It all points out that more research is needed into the problem. Lake Region participates in research work through the National Rural Electric Cooperative Association, which sponsors research at the University of Minnesota.

Lake Region has been working with that research by gathering data on soil conditions and soil types.

"We feel that more research needs to be done on the whole animal question, including the electrical side of it," Peterson said.

Peterson said he supports the bill that is currently before the Minnesota Legislature which would provide funding for research into electromagnetic effects and other issues dealing with animal behavior and production.

However, he questioned how much could actually be accomplished with the \$150,000 that the bill would provide.

Power companies react

4/16/87

Becker C. Resend

by James Campbell

(The following is the last in a series of stories on stray voltage.)

In discussions on the causes and solutions of stray voltage, one group whose role is often misunderstood is that of the power suppliers.

They are often thought to be responsible for the problem and to blame for it. They are sometimes accused of being uncooperative and unresponsive in dealing with the farmers who have stray voltage problems.

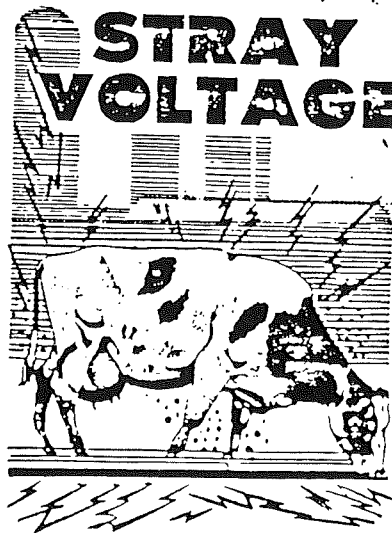
But officials at two local power cooperatives say those accusations are not based on facts. The problem, they say, is that there are no simple answers when talking about stray voltage problems.

Both Wild Rice Electric Cooperative in Mahanomen and Lake Region Power in Pelican Rapids have been examining cases of stray voltage on member farms for that last few years.

Curtis Markert, an engineer with Wild Rice, explains that stray voltage has often been portrayed as being much more of a problem than it really is.

It is fairly common condition, he says, but most of the time it is not associated with any problems.

"There's stray voltage around



all over — your house has it," Markert said. "People just don't feel it. Cows and pigs and chickens, they're among the animals that have low enough resistance that stray voltage does affect them."

Markert makes the point that the potential for stray voltage occurs whenever electrical conductors are not perfect. And, he points out, whether it be because of splices or corrosion or other conditions, conductors are never perfect.

"If the connection is not ideal, and it's never going to be ideal because there's resistance in all connections, the electricity is going to divide at that con-

nection. It's going to take the path of least resistance back to its source," Markert said.

One important fact that is often overlooked about stray voltage is the small amount of current involved, he said.

"It doesn't take much voltage to have a neutral to earth voltage. You're only talking about one volt or less," Markert said.

Yet, Wild Rice does admit that stray voltage can cause problems on some farms. The co-op has checked a number of farms for stray voltage and has installed isolation transformers on 16.

Isolation transformers are the method used to deal with the problem when it is determined that the source of the stray voltage is the ground line coming to the farm.

Before that step is taken, other possible sources for the problem are checked. The first step is to make sure that the source of the stray voltage is not on the farm itself.

That involves getting wiring, grounds, motors and other electric devices all over the farm checked.

"You can find the problem in a lot of different areas," Markert said, adding that the search is often long and difficult.

"Just a bare wire in a pump

motor can do it. It doesn't even cause a pump malfunction."

Markert has also traced the problem to lightning rods with wires that are out of place, various problems with cow trainers, and even a spider web that shorted out a fuse box.

Often the source of the problem is found on the farm after a complete search. If it is not, the search for the source continues on other farms. Service can be temporarily disconnected to other power users along the line. If the problem disappears when a particular farm is disconnected, the search for the source moves to that farm.

Markert explains that stray

Is it his fault that there's neutral to earth voltage on a farm five miles away?" Markert asks.

"There's just so many ways that neutral to earth voltage can get into the system, you just can't blame the power companies."

Clarence Peterson, general manager of Lake Region Electric Co-op Electric Association, emphasizes that stray volt is not some mysterious force, and that it is only one of many factors that affect the production of milk.

"Our observation is that there's a wide range of conditions and situations that may or may not cause an animal

spend enough time at it.

"The problem is that if there is this drop in production in this herd and it was caused by a neutral to earth voltage problem, it's going to take a while before the production comes back again," Peterson said.

Lake Region has tested about 280 farms and has installed about 75 isolation transformers. Peterson said that on seven or eight of those farms, the isolation transformers were later removed at the farmers' request because they didn't seem to be helping with the problem.

Often the nature of the problem can make it that much more difficult to deal with. Lake

Dairy farmers experience impact of stray voltage

by James Campbell

(The following is part of a series on stray voltage and its impact on dairy farming.)

For Frank and Thelma Pesola, it was an expensive, multi-year battle, but they seem to have finally reached a cease fire.

The problems with stray voltage on their New York Mills farm were typical. Their cows had health problems, they couldn't breed and production was down sharply.

Mastitis was rampant in the herd. "You'd treat them and treat them. Once you treat them, you can't sell them, so you have to keep them," Thelma said.

The cows were dying. The ones that remained alive were not producing as much milk as they should. The average of the herd dropped from 15,000 pounds per year to around 10,000.

The Pesolas went into debt replacing the ill cows with fresh, healthy ones, but the new cows were as bad as the old before very long.

They checked the feed and the water. They checked for disease, but no answer was found.

"We did everything right and everything went wrong."

The problems weren't limited to the cows. Thelma would get physically sick in the barn and eventually refused to enter it.

"My arms and legs would go numb," Thelma said. "I would wake up at night and I would have no sensation of my body below my neck."

One of the Pesolas sons suffered from a leg injury that didn't heal while he lived on the farm. After he left, the wound healed, but the problem returned when he resumed living at the farm.

Eventually they checked for stray voltage and over four volts were found in the barn during peak times.

Their power supplier, Lake Region Electric Cooperative, installed an isolation transformer to solve the problem.

"That worked out for about six months," Thelma said.

When no other answer could be found, the Pesolas installed an electronic grounding system at a cost of several thousand dollars to them.

It operates by constantly measuring the stray voltage charge and sending out an equal and opposite charge that neutralizes the stray voltage.

It is the electronic grounding system that has finally given them peace from stray voltage.

The source of the most severe stray voltage was eventually

found to be a faulty extension cord on a neighbor's farm. When that was fixed, it eliminated most of the stray voltage, but the problem still remains at a lower level. The electronic grounding system is still in use.

While the problem is solved for now, the debts that the stray voltage left are still a problem for the Pesolas. Frank continues to work full time in a siding business that he had hoped to be able to leave when they started dairying.

Through it all they have maintained that their power company did little to help them.

"The power companies say it is there but they don't do anything," Thelma said.

They have attempted to go to court and collect damages by

proving that their problem came from off the farm, but have had no success there.

"What's really irritating is we've got the facts," Thelma said. "It's there in black and white and you can't do a bloody thing about it."

"There's nothing you can do. You have the facts, but it's like fighting a war with an invisible enemy."

More recently, the Pesolas have become involved with efforts trying to find an answer to stray voltage problems. They have joined some groups and are working with U.S. Representative Arian Stangeland.

As part of their work with Stangeland, the Pesolas are trying to gather information on stray voltage problems in the area, and ask farmers who may be having those sorts of problems to contact them.

Their address is: Frank and Thelma Pesola, Rt. 3, New York Mills, Minn. 56567.

They stress that they don't have a lot of answers or help to offer to people with stray voltage problems. They are only helping to gather information on the extent of the problem.

Through these efforts they hope some answers will eventually be found.

STRAY VOLTAGE



Physicist Pursues Controversial Stray Voltage Theory

The Farmer-
April 6, 1985

A new approach to stray voltage problems has stirred a major controversy among Minnesota dairy farmers, researchers and ag engineers.

According to a theory advanced by Dahlberg, electromagnetic built-up electrical charges in the barn floors can damage the health and production of dairy cattle.

Dahlberg's electrical field idea differs from mainstream research and approaches to stray voltage. At the University of Minnesota, stray voltage is defined as low-level voltages existing on equipment that come in contact with farm animals.

Dahlberg, a physics professor at Concordia College, Moorhead, MN, admits his theory is untested. The theory is that DC-charged fields build and change the ionic structure of concrete barn floors, affecting the central nervous systems of livestock and people.

He attributes the DC buildup to a combination of natural conditions and "all the electrical energy being put into the ground by massive grounding systems."

University specialists who've worked on AC stray voltage problems are skeptical about Dahlberg's theory. They say his method is not scientifically sound.

Harold Cloud, U of M ag engineer, says he has not seen research data or basic electrical analyses of DC buildup that substantiate Dahlberg's theory. Cloud would like to see the theory presented in a scientifically

sound manner and published so scientific peers can review it.

Ever see a cow standing with her nose pressed against a metal stall divider or her chain? "I'm convinced that animal is trying to drain off an electrical buildup," he states. "I believe it's a response to an electromagnetic field in the body. The animal has learned from experience there's some sort of relief."

Dahlberg, who also is chairman of the Minnesota Pollution Control Agency, compares the ground to a big sink and the dispersal of electricity to a form of pollution.

"What's been happening to all this electrical energy for all these years?" he asks. "We need to look at the grounding systems to see how to get rid of it. Electrical energy is absorbed very quickly, so it should be easy to eliminate."

On leave from his teaching position, Dahlberg has visited about 50 Minnesota dairy farms in the past six months, observing a variety of herd problems that he believes are electrical in nature. He agrees that he needs further evidence to prove the existence of this kind of stray voltage.

"My purpose is to find out what the problem is," he says. "There are lots of loose ends and that's where research comes in."

Limited equipment and virtually no previous research on the subject of charged fields are pitfalls facing Dahlberg. Meters used for measuring AC stray voltage are not sensitive enough to measure DC fields, he says. And an electric field mill that shows DC voltage would cost \$5,000. Dahlberg has been using an

older, less-reliable model in his preliminary work, but now plans to share a field mill with the Minnesota Environmental Quality Board.

Dahlberg is critical of university and power company officials who are unwilling to accept his theories "just because they're not proven scientifically yet. It's difficult to get some-

"What he's proposing is pretty vague. It does not seem to follow what is known from widely accepted stray voltage research."

— Bob Gustafson

thing new recognized by the scientific community. It's a closed, conservative group."

Dahlberg also believes a DC buildup in concrete floors of manufacturing plants and other workplaces may be hurting people.

Symptoms, which farmers might also experience in their barns, may include tired or sore legs, swollen knees, a general tired feeling, headaches and dizziness.

A group of farmers, encouraged by Dahlberg's preliminary work, has organized to solicit and distribute funds to continue the project. Called Research to Resolve Stray Voltage (RSVP), the group plans to attain non-profit status.

"I'm convinced this is something we can't quit on," Dahlberg told about 200 farmers, local businessmen and power company representatives at a recent meeting. "This may be as big to the general public as it is to dairy farmers." □

believes AC induction electromagnetic waves emanates from powerlines and electrical equipment, aggravate the effects of the DC field in a barn floor. In combination, induction currents and DC fields change the electrochemical nature of animals' bodies.

"My contention is that those two factors together are causing basic problems," he says. "And I haven't ruled out other possibilities. I'm not

RURAL DE-LIGHT

May,
1985

Stray voltage: A Warning to Dairy Farmers

If you suspect that you have a problem with stray voltage, the first step is to have your licensed electrician check your equipment in the barn and making sure that the load is balanced as nearly as possible. If the problem still exists, contact Wild Rice Electric Co-op.

(The following information is reprinted from the Agricultural Extension Service University of Minnesota Extension Folder No. 552, entitled Stray Voltage Problems with Dairy Cows. This segment deals with stray voltage symptoms, and should be helpful in determining if a problem exists.)

SYMPTOMS OF STRAY VOLTAGE PROBLEMS

Animal reactions will vary depending upon the severity of the problem. If one or more of the following symptoms persists, stray voltage may be contributing to the problem:

(1) **UNEVEN MILK OUT.** This is the most common symptom expressed by dairymen. The number of cows affected and the severity of the milk let-down problem appear to be dependent on the level of stray voltage present. The mechanism of how this occurs is not understood. When milk out is uneven, more machine stripping is required and longer milking time becomes apparent.

(2) **COWS EXTREMELY NERVOUS WHILE IN THE PARLOR.** This trait often is characterized by the cows dancing or stepping around almost continuously while in the parlor stall. However, dairymen are reminded that cows may become nervous for other reasons, such as malfunctioning milking equipment or rough handling by the operator.

(3) **COWS RELUCTANT TO ENTER THE PARLOR.** When cows are subjected to stray voltages in the parlor stalls, they soon become reluctant to enter the parlor. In extreme cases, nearly all cows have had to be driven into the parlor and there was a tendency to "stamped" out of the parlor upon release. But again, this symptom is not specific since cows may be trained to expect the parlor operator to chase them into the milking stalls.

(4) **INCREASED MASTITIS.** When milk out is incomplete, more mastitis is likely to occur. All that is required is the presence of infectious bacteria. This, in turn, will result in an increased somatic cell count.

(5) **REDUCED FEED INTAKE IN THE PARLOR.** If cows detect stray voltage while eating from the grain feeders, a reluctance to eat and reduced feed intake is almost certain to occur.

(6) **RELUCTANCE TO DRINK WATER.** Stray voltages may reach the cows in stall barns through the water supply or metal drinking cups. Thus, cows soon become reluctant to drink.

(7) **LOWERED MILK PRODUCTION.** Each of the symptoms described previously is associated with stress, reduced nutrient intake, or disease. In any case, a drop in daily milk production is to be expected. Even when the stray voltage problem has been corrected, milk production may remain abnormally low for awhile because of the associated problems.

It must be remembered that other factors such as mistreatment, milking machine problems, disease, sanitation, and nutritional disorders can create problems which manifest themselves in the above seven symptoms. A careful analysis of all possible causes is necessary if the proper corrective procedure is to be found.

the farmers involved in the meeting at the David Lusty farm were finding, was that they were all experiencing similar problems. Most there had had previous problems with stray AC voltage and after solving that problem found that after a period of improvement in milk production, problems surfaced.

Dahlberg stated, "that even with isolation corrections (finding new paths for stray AC voltage) the basic physical problems for the cows did not stay solved. The more obvious problems that are experienced in barns found to have stray voltage are slow milk letdown, meaning a longer period of time to do the milking, lowering of milk production even with good management programs and problems in breeding, such as premature births, along with recurring health problems in the cows. This leads to a lot of frustration for the farmer experiencing these problems, not to mention the dollar loss. I think I know where it's coming from and I feel there are two major sources."

If setting up his study for stray DC voltage, Dahlberg found that he could not find anyone who had done any previous work in this field, but he stated, "Runestone, Lake Region and Otter Tail Power Companies are willing to work with me in this study and I expect to be hearing from other power companies as well, in cooperation with this study. I cannot find the working alone, so I plan to work closely with the farmer as well, because you cannot duplicate in the lab what is on a farm." Results of both Dahlberg's study and that done at the University of Minnesota will be shared.

Dahlberg will be using the David Lusty farm of Miltna and the David Hagen farm of rural Underwood as part of his basis in the study as both farmers have experienced stray AC voltage problems, corrected them and are now experiencing similar problems after a period of improvement with no evidence of stray AC voltage. The Hagen farm has been clean of AC and testing showed that there was no AC in the barn, yet even with very good management, lower milk production, milk letdown, and premature births, are problems that still plague them along with a number of other problems. The Lusty farm too, dealt with their stray AC voltage problem only to find that improvement was short-lived. Attempting to isolate the problem, Lusty found that during the summer when he could keep his cows outside the barn more, his herd production improved.

With a number of variables, Dahlberg has found some constants in his study thus far. Concrete, and moisture are two that seem to be involved, as he has found that both are involved in stray voltage problems. There seems to be some connection with electrical changes, such as going to a bigger service or a change in distribution on the electrical systems on the farms. Two other natural factors are that farms experiencing stray voltage problems are located in the lakes region and the depth of the frost line seems to be a variable in the amount of DC build-up as frost is a poor conductor of electricity. Dahlberg has also found build-up in the yards as well as the barn.

"Political problems in finding the source in this study are as great as the scientific problems," states

Dr. Kent Smith, local veterinarian, expects that this study will be a positive factor for the veterinary profession as they deal with so many of these problems in their treatment of the cows.

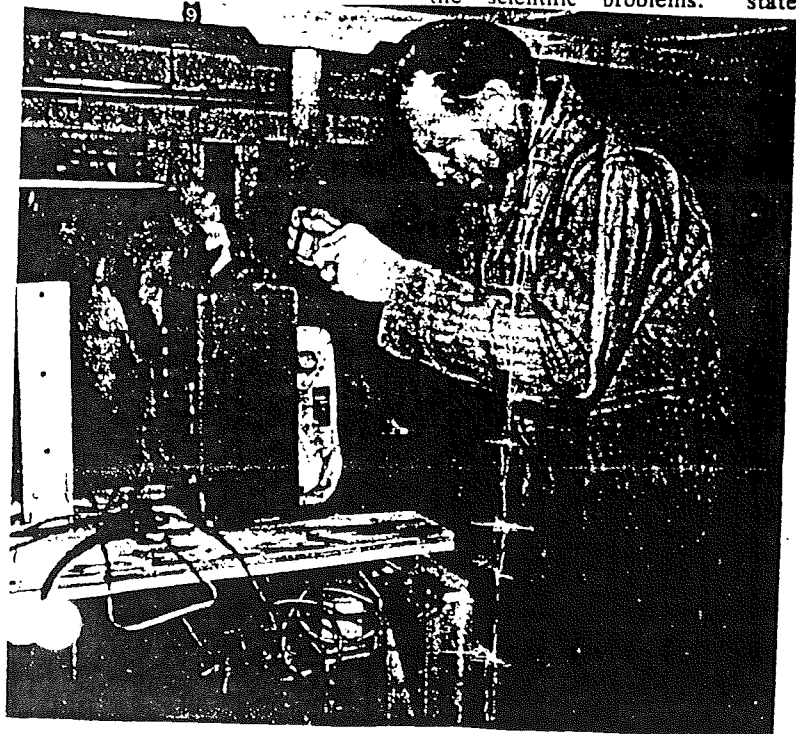
This study got off the ground when farmers such as Lusty contacted his legislator and requested some legislative help. Legislator Rick Krueger investigated the problem, found very little information on stray DC voltage although AC voltage problems were reported to the U of M. "It became evident there was more to it," stated Krueger. Krueger then sponsored a bill requesting a grant to study the problem. After two years the bill was passed giving the U of Minnesota part of the \$65,000 and Dahlberg part to study the how, why and effects of build-up of stray DC voltage.

There will be a meeting with the University of Minnesota, Dahlberg and farmers experiencing stray voltage problems in the near future to discuss the problems experienced. Information will be released on date and time as soon as the meeting is set.

Dr. Dahlberg is not limiting his work to just the Lusty and Hagen farms, he wants to hear from any farmer that is experiencing any of the problems mentioned. He expects to be going to as many farms as possible to make measurements as he feels farmers are his best source of information. Thus far he has found no farms

where there is no problem. If any farmer is dealing with recurring problems that he feels might be due to stray voltage, or suspects, but is not sure that it is, he is encouraged to write to Dr. Dahlberg at 421 Horn Avenue So., Moorhead, MN 56560.

"This is so frustrating for the farmer, who is a good manager, to see his herd production go down no matter what he does to improve it," commented Dahlberg, and I hope to help him through this study."



DR. DUANE DAHLBERG sets up the equipment he uses to measure stray DC voltage, in the David Lusty barn near Miltna.

The Independent

Stray voltage solution sought through study

Oct 24, 1984

Stray DC voltage was the topic of discussion this past week when a group of farmers met with Dr. Duane Dahlberg at the David Lusty home in rural Miltna. Conversation centered on various problems experienced by the farmers with their livestock in barns, especially with those problems experienced in milk production.

Dr. Dahlberg, a physicist, under contract with the Minnesota Dept. of Agriculture, will be working with farmers in attempting to find the cause of problems that are affecting milk production in barns that have been plagued by stray voltage.

Under a grant of \$65,000 that is to be shared by the University of Minnesota, Dahlberg, on leave from Concordia College, Moorhead, will spend the next year studying farms that are experiencing problems with stray voltage, especially in the area of dairy production.

Stray AC (Alternating Current)

voltage has been a problem that has plagued farmers and a number of studies have been done on it. This study will concentrate on the possibility of stray DC (Direct Current) voltage of which no earlier studies have been done. Dahlberg explained that he has found a positive charge build-up in barns and the soil surrounding the barns with equipment made to measure DC (Direct Current). There should not be a positive charge but a negative in known normal atmospheric conditions.

The technicalities of what stray DC voltage is and how it builds up

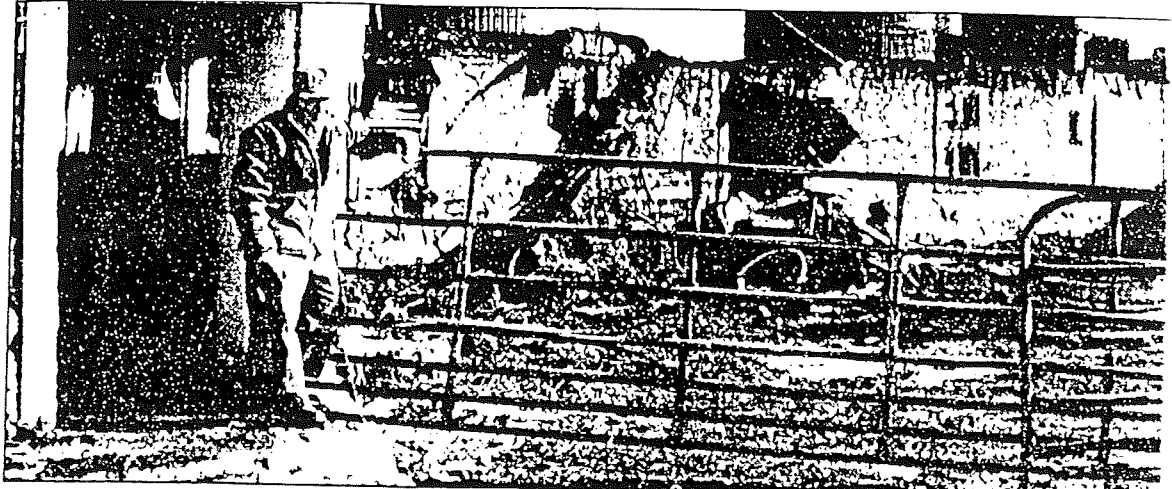
With equipment to measure DC (Direct Current) build-up Dahlberg emphasized, "farms are not the only places that I have found DC build-up, nor are only cows affected by it. I have found DC build-up in a number of machine shops and have found that hog farrowing is affected, as well as there being a sensitivity to it by humans. Human sensitivity may be aching legs, fatigue, swollen joints, headaches and even disorientation after a period of time in the barn or shop. Although humans are less susceptible, animals are found to be very sensitive to what is



Stray voltage

DON FRIESE, Rose City looks on as Dr. Dahlberg explains the readings on his measuring equipment to Dave Lusty, Miltna and Dave Hagen, Underwood, two farms that have been involved in his study of stray DC voltage.

Electrical fire?



ECKHARDT (SHORTY) NIMTZ said the barn on his Chippewa County farm had stray voltage problems several years before the recent fire. The blaze destroyed the barn, about 10,000 bales of hay, 3,000 bales of

straw and 4,000 bushels of grain in a granary attached to the barn. Three silos also were leveled. Damage caused an estimated \$200,000 in damages.

Stray voltage: '60 Minutes' plans segment on farmer's allegations

By JUDY BROWN
Special to The Journal

A crew from the CBS News program "60 Minutes" is preparing a story on the effects of stray voltage on Wisconsin dairy farms.

The segment, expected to be broadcast sometime in February, will feature Wally Daggett, a Sheboygan County dairy farmer who has been an activist on the issue of stray voltage for several years.

By the time the program airs, Daggett and his wife, Joan, may be forced from their home by creditors. They have not paid rent since August, and they face an eviction notice with a Friday deadline. Their 236-acre farm owned by Farm Credit Services.

This month, the State Agriculture Board called for an audit of how public agencies and power companies manage the problem of stray voltage, an electrical field that is produced by power lines and that can be felt by cattle and not hu-

mans. The phenomenon sends electrical charges through metal items, such as milking machines and water cups, and is thought to cause health and production problems in farm animals.

CBS correspondent Ed Bradley recently interviewed the Daggetts in their home in rural Random Lake on the effects of stray voltage on herds, families and communities.

"I want the nation to know that stray voltage is a serious problem," Daggett said. He said his losses caused by stray voltage had been so extensive that foreclosure proceedings began in 1988 — even though a Sheboygan County jury awarded him \$1.1 million in a lawsuit against Wisconsin Electric in 1984.

Daggett told CBS he'd lost 544 cows between 1973 and 1984. That total does not include cows he sold for slaughter because they were poor producers, aborted cows or calves that did not survive until adulthood. He said he still was

milking many cows that showed the effects of stray voltage.

"It takes a lifetime to build up a good herd," Daggett said.

OTHER FARMERS INTERVIEWED

The CBS crew interviewed others familiar with the stray voltage issue. They traveled to Sheboygan County to talk to Ron Hamann, whose farm was surveyed by the state's Stray Voltage Assessment Team. A Michigan dairy farming family that had won a stray voltage lawsuit was interviewed, as were a number of others who have dealt with stray voltage problems, including Al Biesber, a Kewaskum electrician who has visited more than 3,000 farms, and Scott Lawrence, a St. Nazianz attorney who has handled stray voltage lawsuits.

A Chippewa County farmer, David Nimitz, 25, of Bloomer, blames stray voltage for causing a fire that destroyed his barn Jan. 12.

The Chippewa Valley Electric Co. and a Stray Voltage Assess-

ment Team said they thought problems with stray voltage were corrected before the fire. But team member who has since been suspended said he thought judgment was wrong.

The fire destroyed the 36 124-foot barn, about 10,000 bales of hay, 3,000 bales of straw, 4,000 bushels of grain in a granary attached to the barn, and three silos. Damage was estimated at \$200,000.

An electrician discovered stray voltage on the farm in June 1989, so Nimitz spent \$10,000 to have the barn rewired. The problem was corrected a short time later.

Ray Guthman, general manager of Chippewa Valley Electric, said some stray voltage had been found at the site, and an isolator was installed to neutralize the problem. "I don't think there were high voltages present" when the fire broke out, Guthman said.

The Associated Press contributed to this story.

Family Awarded \$1 Million in Stray Voltage Suit

*But the real reward
comes at milking
time, says Dale
ZumBerge.*



For 13 years, Dale ZumBerge fought a hidden enemy – stray voltage – that took the fun, and much of the profit, out of dairying.

This year he solved the problem. He also won a \$1 million lawsuit against the electric utility behind it.

Whether ZumBerge collects on the lawsuit remains open to question. The utility, Northern States Power Co. (NSP), still could appeal the award, the largest-ever for a stray voltage case in Minnesota.

But ZumBerge says the important thing is that his cows aren't jumpy anymore. And milk production is rising.

"I don't care about the money," says ZumBerge, who runs the 80-cow herd with his wife, Gloria, and his son, Steve, near Green Isle, MN.

ZumBerge still feels the weight of those "lost" years.

"It got so that I didn't even want to go down to the barn anymore," he says.

It was clear the cows weren't too happy with their lot, either.

Milk production plummeted.

BY KRISTI LEE JOHNSON

Over the 13 years, an estimated \$500,000 in milk revenue was lost. Another \$1 million in losses resulted from heavy culling, extra time in the barn and "opportunity" losses from skimpy profits.

The family's stray voltage saga started in 1977. Back then, the herd was one of the top 100 dairies in the state. Steve and his sisters, Brenda and Kristine, were winning state fair 4-H championships with the cows.

So the ZumBerges decided to expand. But instead of watching production rise, they saw milk checks drop.

"We were using the same feed, the same genetics and we had better equipment," he says. "But things just kept going downhill. We had breeding problems, mastitis problems. The cows kicked. They were nervous and restless. It just got to be a nightmare."

Short tempers around the farm weren't confined to the cows.

"You know, you blame the feed, you blame the breeding, you go to all the meetings and everyone has an answer for you," says ZumBerge. "But it takes six months to see a change, and six months would go by, and then a year, and things were still going down."

Then, in 1984, ZumBerge read an article about stray voltage. It explained how electricity takes the path of least resistance. If there is improper grounding in a barn, or if power company lines are poorly grounded, current will wander along avenues of least resistance – like through cows on a damp floor drinking from a waterer – instead of back to the transformer.

To make matters worse, he read, cows are extremely sensitive to low levels of electricity. Mastitis, nervousness, breeding problems and poor milk-out often result. ZumBerge recognized the signs – and called his Surge dealer to come out and test.

"He said he was going to have to charge me \$40 an hour," says ZumBerge. "I said 'Come right over.'"

The dealer found 2-3 volts of "stray" electricity running through cow contact points like water cups and stanchions. In Wisconsin, which has an aggressive program to control stray voltage, 1/2 volt is considered a problem.

ZumBerge's electrician also found stray voltage, and determined it had to be removed from off the farm. When NSF testing also confirmed the problem,

Cows got a charge out of NSP

Farmers win \$1 million in suit

By Donna Halvorsen
Staff Writer

A jury has awarded \$1 million to Sibley County dairy farmers who claimed that their cows' milk production dropped substantially because of stray electrical current in their barn.

The damages were awarded to Dale and Gloria ZumBerge and their son, Steven, who farm 600 acres near Green Isle.

They had sued Northern States Power Co. They said NSP failed to warn about stray voltage — errant electricity that enters the ground from grounded electrical distribution systems — and failed to bring it under control once it was discovered.

The verdict came late Tuesday, after a 2½-week trial in Sibley County District Court in Gaylord. The jury deliberated less than two hours.

"It took a tremendous load off our shoulders," Dale ZumBerge said.

It is the first verdict against NSP in a stray-voltage case, according to Minneapolis attorney Jim Kaster. He and his partner, Jeffrey Anderson, represented the ZumBerges.

The problem of stray voltage was recognized by researchers in several nations as early as the 1940s. They cited health dangers from current that flowed through the ground, into barns and into the bodies of cows and dairy farmers.

Kaster said stray voltage has nothing to do with the controversy surrounding high-voltage power lines, such as the proposed 164-mile line that caused a near revolt in the mid-1970s. Central Minnesota farmers had harm from stray current that would come from the lines.

In 1986, physics Prof. Duane Dahlberg of Concordia College in Moorhead, Minn., then chairman of the Minnesota Pollution Control Agency, said central Minnesota farmers were right to be concerned about health problems from electricity. "But there's a far greater effect from electrical energy coming through the ground," he said.

Kaster said, "There's uniform agreement that it's a serious problem. There is not uniform agreement about the levels at which it's a serious problem."

He said that the University of Minnesota Extension Service warned farmers of the dangers of stray voltage in 1980 but that the ZumBerges didn't find out about it until 1984, when they read about it in a magazine.

"We called our local milk machine dealer to see if they knew about anybody who would check for stray voltage," Dale ZumBerge said yesterday. "We just thought there would be a chance, and they came out and checked and found out we had it."

By then the ZumBerges' milk production had fallen below the state average. In 1976-77 they had been among the top 100 dairy producers in the state.

NSP installed a device to keep the current out. "That was in August '84, and in November '84, they came back without our knowledge and put a new pole and transformer in and hooked it up wrong," ZumBerge said.

As a result, Kaster said, stray voltage continued to enter the barn, although in smaller amounts than before, passing into the cows' bodies. The ZumBerges sued NSP in 1986.

"In October '87 NSP came out with their expert and they found stray voltage but they didn't tell us about it," ZumBerge said. "In October '89 we had our expert out and he discovered we had it, and he discovered it (the device to block the current) was hooked up wrong."

Milk production is up 200 pounds a month per cow since the problem was corrected earlier this year, ZumBerge said. The cows are "much better than they have in years."

Kaster said cows are especially affected by stray voltage. They have only 10 percent of the resistance to electricity that humans have, he said.

Farmers awarded \$1 million in stray voltage case

Associated Press

Gaylord, Minn.

Green Isle dairy farmers, who said stray electrical current substantially cut their cows' milk production, have been awarded \$1 million by a jury.

Dale and Gloria ZumBerge and their son, Steven, had sued Northern States Power Co., claiming NSP failed to warn them about stray voltage — errant electricity that enters the ground from

grounded electrical distribution systems. They also said NSP failed to bring it under control once it was discovered.

A Sibley County District Court jury awarded the damages Tuesday after a 2½-week trial.

"It took a tremendous load off our shoulders," Dale ZumBerge said of the verdict. He said he pressed the case partly out of pride to prove that his cows' problems were not the result of poor

management.

It is the first verdict against NSP in a stray-voltage case, according to Minneapolis attorney Jim Kaster. He and his partner, Jeffrey Anderson, represented the ZumBerges.

Sam Macaluso, NSP spokesman, said the company may appeal. He said NSP's position "is that the evidence in the case doesn't demonstrate the reduction in dairy production was due to stray voltage."

The electricity was coming from a neutral wire, which is supposed to take electricity back to the generator. The neutral wire is grounded in the electric service box in the barn.

The problem of stray voltage was recognized by researchers in several nations as early as the 1940s. They cited health dangers from current that flowed through the ground, into barns and into the bodies of cows and dairy farmers.

Is management taking a bum rap for stray voltage?

A meeting organized by concerned farmers will be held at the Parkers Prairie Elementary School on February 9, 1985, from 10:30 a.m. to 3:30 p.m. Noon lunch will be available.

If you are having some of the following problems, management may not be the culprit:

- Uneven, incomplete and/or slow milkout;
- Poor water consumption;
- Multiple or recurring mastitis (Not responding to treatment);
- Cows reluctant to enter barn and/or stalls;
- Breedback difficulties;
- Cow production peaking early and not holding;
- Swollen legs and joints;
- Dancing of cattle back and forth in stalls;
- Cattle kicking milkers off.

Stray voltage may be affecting your herd.

There is a growing concern that farm isolation from the Primary Neutral servicing the farm is not the complete cure, as continued research is revealing. Everyone is welcome to come and learn.

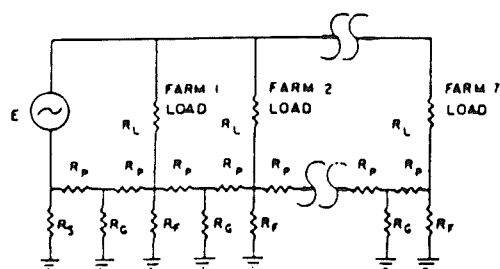
Speakers and guests include: Dr. Duane Dahlberg, Physicist, Concordia College; local veterinarians; electrical contractors; dairy equipment dealers; legislative representatives; state ag officials; ag extension representatives and electrical suppliers.

If you have questions, please contact David Hagen, (218) 826-6401, Underwood, Minn.; David Lusty, (218) 943-5581, Milotona; Milo Mugaas, (218) 739-9235, Fergus Falls or Bruce Shol, (218) 736-7920, Fergus Falls.

Good crowd at voltage meeting



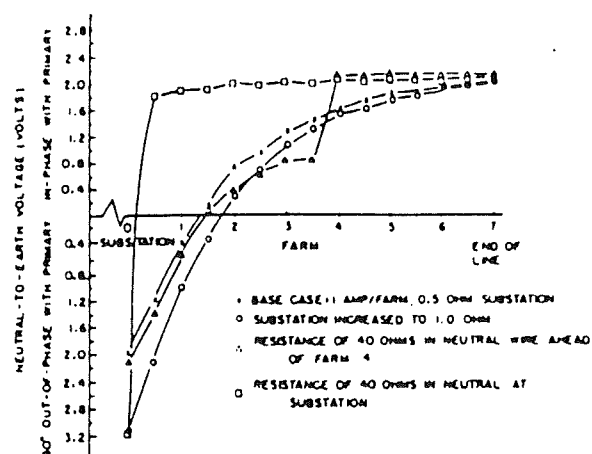
APPROXIMATELY 200 area dairy farmers, together with other interested professions attended the Stray Voltage meeting Saturday at the elementary school in Parkers Prairie. They spent the day hearing from representatives of the utility companies, the university, the legislature and a veterinarian. Dr. Duane Dahlberg of Moorhead is shown as he speaks to the group about his findings on the effects of stray DC voltage in dairy barns. Dahlberg, a physicist, has been involved in a study of stray DC voltage which has included some area dairy farms. From Saturday's meeting, a committee of dairy farmers, with representatives from utilities, the universities, legislative, as well as other related dairy farming industries was formed to continue to find funding as well as encourage the continued study of the stray voltage problem.



E = SYSTEM SUPPLY VOLTAGE = 720 V
 R_L = FARMSTEAD LOAD RESISTANCE = 720 OHMS
 R_s = SUBSTATION GROUNDING RESISTANCE = 0.5 OHMS
 R_p = PRIMARY NEUTRAL CONDUCTOR RESISTANCE = 0.33 OHMS
 R_G = PRIMARY NEUTRAL SYSTEM GROUNDING = 12.5 OHMS
 R_f = FARMSTEAD AND TRANSFORMER SYSTEM GROUNDING = 2.5 OHMS

A seven-farm, single-phase line model, shown schematically above, was used for the base case representation in this study. The model assumes a very uniform line with: an equivalent system grounding of 2.5 ohms at each farm; 12.5 ohms of system grounding at the midpoint between farms and of the first farm and the substation; primary neutral conductor resistance of 0.66 ohms between farms; and a substation resistance of 0.5 ohms. The model assumes purely resistive components throughout. Resistance of each farmstead load was set at a value which produced a 1-A load.

A system of twenty-one loop equations was



established from the circuit description. A simple matrix solution program on an Apple IIe was used to solve the equation system. A solution time of approximately 60 s was required for each loading or configuration.

An additional source loop, requiring one more equation, was inserted to represent the current offset device application. The source was placed between the earth and the selected point in the grounded neutral system.

The graph shows some additional results of exercising the model to demonstrate the effect of changing selected resistance parameters.

A second approach to single-service isolation has been developed by Ontario Hydro in cooperation with Hammond Electrical Industries, and is now approved for use in Canada. This approach, Fig. 10, makes use of a saturating reactor for separating the grounded (neutral) conductors from the grounding conductors, including the grounding electrode, at the building service entrance. Under normal conditions, the reactor acts as the large impedance of a voltage divider in series with the building grounding system. Since potential fault currents on the secondary are larger than for the primary side, the specifications for this application may be more stringent than for application of the same principle at the distribution transformer.

This approach has the advantage of low cost of the device. However, since its function depends on complete

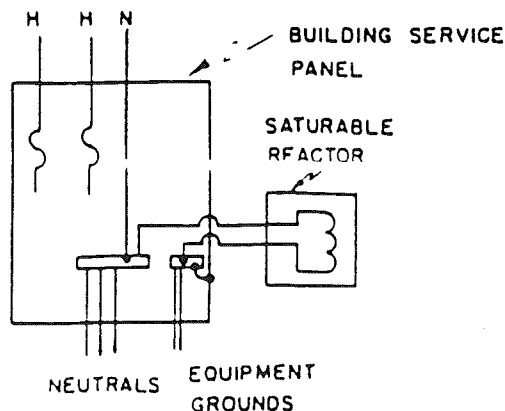


Fig. 10—Saturating reactor application at a building service entrance.

separation of grounding and neutrals within the service and separation of grounding systems between services. installation may be difficult in some existing facilities.

Devices for this approach have not received listing by Underwriter's Laboratory for such an application. The concept has not been determined to be acceptable under the National Electric Code. Therefore, its use in the US at this time can not be recommended unless approved by appropriate electrical inspection authorities on an experimental basis.

SUMMARY

Three concepts — voltage reduction, gradient control and isolation — are available for dealing with stray voltage problems. Since most on-farm sources can be adequately dealt with by improvement of wiring and elimination of faults (voltage reduction), the principal development work has been concentrated on methods for dealing with off-farm sources.

The most common off-farm source is the inherent impedance of the primary grounded neutral system. Since in many situations it will not be practical to lower the impedance to a level where problem voltages for livestock cannot arise, other alternatives are being explored. Active voltage suppression, gradient control and isolation techniques are options which can be considered. Further work is needed to assist the industry in development and selection of appropriate approaches that meet the needs of specific situations.

This article adapted from ASAE Paper No. 84-3004. For details on ordering complete paper see instructions in Technical Highlights or on the Reader Service Cards with this issue.

distribution system neutral and grounding. Such systems represent an investment in the range of \$1,000 to \$3,000, plus the cost of operating losses of the transformer. Care must be exercised in proper installation to meet prevailing codes and recommendations, particularly for overcurrent protection and bonding.

Both the spark-gap and isolating-transformer approach rely on an arrestor to interconnect the two systems during an overvoltage situation such as a lightning strike.

Because of the disadvantages of both the spark-gap and isolating-transformer approaches, other alternative devices have been developed. They are based on the concept of placing, at a key point in the system, a device that presents a high impedance under normal conditions but reduces to a low impedance under fault conditions. These devices can replace the simple spark gap as an interconnect between primary and secondary neutrals at the distribution transformer.

Two concepts for these devices are available at this time. One uses a saturating reactor, which is a conductive with a core that magnetically saturates when the current through the coil increases. Thus, the device presents a high impedance at low currents, but saturates and presents a low resistance at high currents. The available devices reach saturation at potentials in the range of 10 to 24 VAC. The saturating reactor blocks most of the NE voltage under normal operating conditions by acting as the higher impedance in a voltage divider with the farmstead grounding system. However, under fault conditions where the potential across the device would increase, the reactor saturates and presents a very low impedance. Fig. 8 shows a characteristic 60-Hz AC impedance curve for one such device. Saturating reactors do not conduct (saturate) for steep transients such as lightning. Therefore all these devices have a surge arrestor across their terminals to prevent damage by lightning or switching transients.

A second isolating device consists of a solid-state switch. The switch consists of oppositely-directed thyristors in parallel, which are fired when the voltage across them reaches a preset value. This effectively returns the bond during fault conditions, while blocking the NE voltage with a high impedance below the triggering threshold. In contrast to the coil, which presents only a low resistance to DC currents, the solid-

state switch blocks both AC and DC currents below the triggering threshold.

An additional reactor has been tested recently. The devices, specifically designed for this application, were unaffected by fault currents up to 2000 A for time necessary to clear 20-A T-length distribution system fuses. The solid-state switch passed fault tests at all levels except 3000 A, where it locked in the triggered (short-circuit) mode. This was expected, since the switch rating was greatly exceeded. The manufacturer states that this switch can be used with a current-limiting fuse where fault currents might exceed the device capability. A higher rated device is also available.

Both the saturating reactors and solid-state devices present a low impedance to fault currents. However under fault conditions, the reactors allowed spikes of up to 290 V across them (perhaps due to 180-deg resaturation every half-cycle), whereas the switch limited the voltage to spikes of about 40 V before it switched to the conducting mode.

These devices reduce the risk of operating with non-interconnected neutrals to a lower level compared to the spark gap at a cost much lower than the isolating transformer approach. However, as discussed earlier, they raise the NE potential on the distribution system during normal operation.

Single Building Isolation

If a satisfactory solution can be obtained by isolation of a single building service, an isolating transformer can be used for a single service, Fig. 9. Depending on farmstead load, the transformer for the single service can be smaller and less expensive than a transformer for the entire farmstead. At this location, the transformer also eliminates secondary neutral voltage drops from affecting the isolated system and minimizes the loss of system grounding to the remainder of the system. However, in many dairy facilities the principle system grounding may be a result of the services needing isolation. When an isolating transformer is installed, assurance is necessary that no conductive interconnections are bypassing the transformer. Common interconnections are metallic gas or water pipes, metal feeders, fences, and connected metal buildings. Any conductive bypass negates the isolation of the transformer.

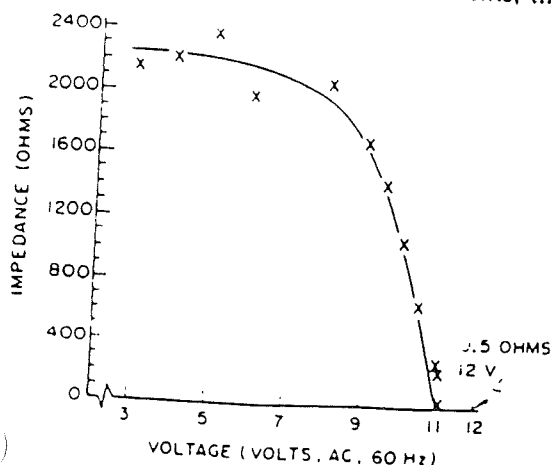


Fig. 8—Impedance curve (60-Hz AC) for one saturating reactor.

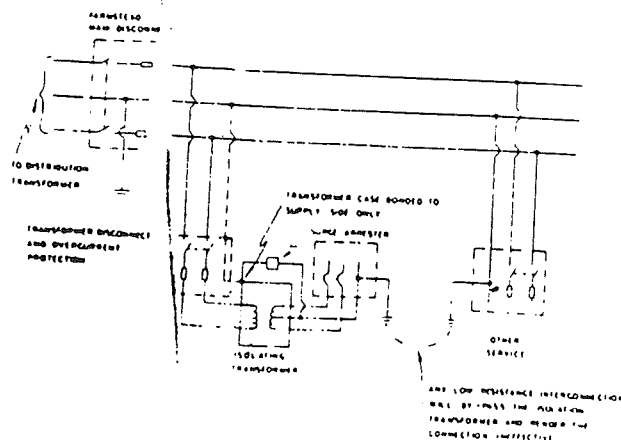


Fig. 9—Isolating transformer installation — single service.

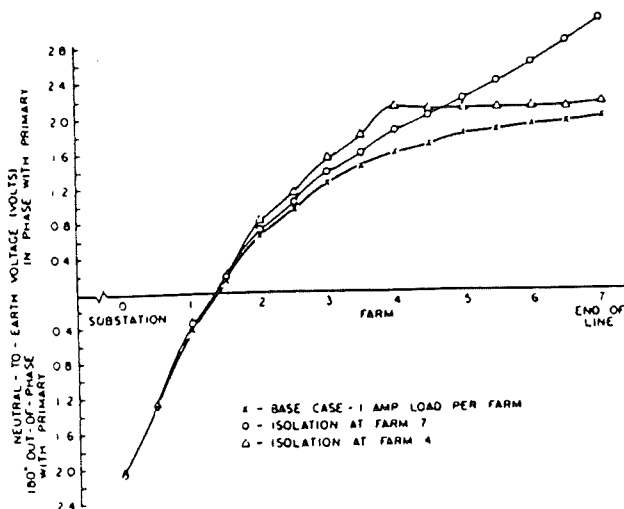


Fig. 5—NE voltage changes due to farmstead isolations.

around electrical equipment. In addition to the objective of protecting persons, animals, and equipment under fault conditions, equipotential planes in livestock facilities are an attempt to reduce problems arising from naturally occurring potentials to levels well below those causing direct harm. Equipotential planes improve the electrical safety with regard to lightning protection and clearing of faults without harm to people or animals. The plane is an excellent grounding electrode for the system.

Limited descriptions of procedures for installation in new facilities have been presented by several authors. However, all of these are based on engineering judgement with little validation of their effectiveness in actual situations. Ontario Hydro reports that their analysis of grid size demonstrates that meshes up to 305-mm (12-in.) square are effective in producing an acceptable plane.

Equipotential planes can successfully minimize stray voltage problems independent of source. However, consideration must be given to all areas where electrically grounded equipment is located in space occupied by livestock or exposed to livestock traffic. Additional methods other than equipotential planes may be needed in certain areas.

Isolation

Isolation of part of the grounded neutral or grounding systems can eliminate access to NE voltages by animals in contact with the isolated system. If isolation is selected, on a conventional single-phase grounded neutral system, two points lend themselves to isolation: 1. Isolating the entire farmstead from the primary distribution system. 2. Isolating the grounding or grounded neutral system at a single building service. For all isolation procedures, careful consideration must be given to both the safety and operational effects.

Whole Farm Isolation

Three procedures are currently being used for whole farm isolation: 1. Isolated neutrals at the distribution transformer with a surge arrester. 2. Isolated neutrals at the distribution transformer with a switching/reconnect device for fault conditions. 3. Isolation transformers in

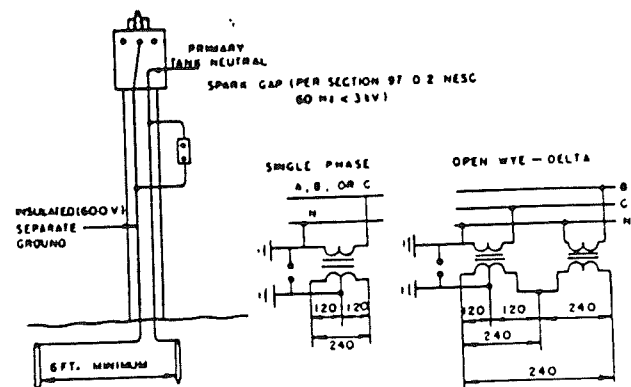


Fig. 6—Distribution transformer isolation with a spark gap.

series following the distribution transformer. In all cases the system grounding of the isolated portion is removed from the distribution system, at least during non-fault conditions. This increases the NE voltage on the distribution neutral. The effect of isolation at two different points is demonstrated in Fig. 5, using the example system. The magnitude of the changes depends on both system loading and grounding. Power suppliers must be aware of loss of this system grounding because it may increase the NE voltage on neighboring services.

Whole farm isolation can be accomplished by removal of all bonds between the primary and secondary neutrals at the distribution transformer, Fig. 6.

Some power suppliers are reluctant to use the spark gap approach due to increased stressing of the transformer by: high voltage transients, loss of system grounding during normal operation, potential loss of system grounding under some fault conditions, and potential safety and maintenance problems due to the non-standard nature of the configuration. With the spark-gap installation, a primary-to-secondary transformer fault below the breakdown voltage of the gap would depend on only the farmstead grounding for clearing the fault rather than both distribution system and farmstead system grounding. However, other devices have been developed to alleviate this problem.

Isolating transformers, Fig. 7, are used extensively to create a separate grounded neutral system on the farmstead. In this system, a primary-to-secondary fault in the distribution transformer is carried by the

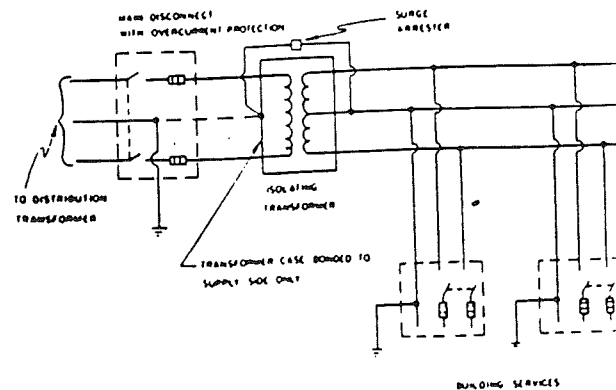


Fig. 7—Isolating transformer installation — whole farmstead

December, 1984

Techniques for COPING WITH STRAY VOLTAGES

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ELIMINATION of existing neutral-to-earth (NE) voltage problems and design for prevention of future problems both demand careful consideration of sources, animal sensitivity thresholds, and characteristics of the mitigation procedures or devices. Clear definition of the effects of any electrical system modifications or design changes on the operation of the system, under normal and fault conditions, is necessary. This article discusses electrical fundamentals of various approaches and some of their potential advantages and limitations.

Methods for controlling NE voltages include:

- Voltage reduction either by elimination of the voltage source (for example, by removing bad neutral connections and faulty loads or improving or correcting wiring and loading), or by active suppression of the voltage by a nulling device.
- Gradient control by use of equipotential planes and transition zones to maintain the animal's step and touch potentials at an acceptable level.
- Isolation of the portion of the grounding or grounded neutral system accessible to the animals, so that they will not be subjected to objectionable currents due to NE voltage existing on the remainder of the grounded neutral system.

In dealing with existing problems, the sources of stray voltage in the facility must be clearly identified. In design of new facilities, an understanding of the potential sources is important.

Understanding of the nature of various sources and mitigation approaches can be improved by the use of circuit models that demonstrate the concepts. In this article, a simple single-phase, seven-farm system with uniform loading is used as an example. See the accompanying box for description of the model, assumptions, and development.

All the devices and procedures discussed are theoretically sound. Each has its specific advantages — and limitations. Some of the devices are still under development; therefore, their specific design may change.

Voltage Reduction

Voltage reduction can be obtained by elimination or reduction of sources or by active suppression.

Elimination or Reduction of Sources

If a systematic analysis shows that a significant proportion of the NE voltage is originating due to such items as high resistance connections (either on or off the farm), excessive neutral imbalance currents on the farm, undersized neutrals, or faults to earth or equipment grounding, then corrections can be made and the subsequent remaining voltage assessed. Obviously, such defects as faulty connections and faults to earth can lead

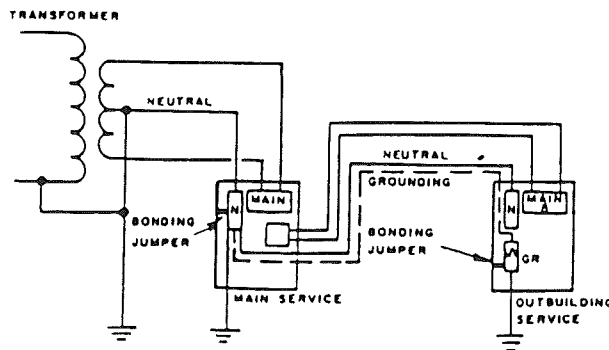


Fig. 1—A four-wire feeder from farm main to outbuilding.

Nov. 28, 1984

Something in the Air Has Nervous Cows Doing a Barn Dance

Farmers Blame Stray Voltage
For Putting Dairy Herds
In No Mood to Let Go

By RICHARD GIBSON

Staff Reporter of THE WALL STREET JOURNAL

KEWAUNEE, Wis. — For the longest time, there weren't many contented cows at Dan and Marg Stangel's dairy farm. The Holsteins would twitch nervously at their twice-daily milkings. Sometimes they avoided their feed troughs. Milk production fell off.

The Stangels weren't very content either, but they couldn't figure out what the problem was. "We run this place according to the book," Mr. Stangel says, surveying his 900-acre quilt of green and gold plots spread out alongside Lake Michigan. Consultants he called in "just thought I was nuts," he says.

The culprit, it seems, was an electrical gremlin that is vexing dairy farmers and cows across the continent: stray voltage. These wandering electrical charges, by putting cows out of the mood to eat or give milk, may be costing U.S. dairymen millions of dollars a year, some industry people believe. Half the dairy herds in Canada may be potential victims, Ontario's Ministry of Agriculture and Food estimates.

The concerns have brought forth scientific studies, national symposiums and learned papers. And, though the importance of stray voltage in dairy production is doubted by many scientists, the matter has found its way to the courts. Suddenly, some lawyers in dairy country are taking crash courses in Ohm's laws of electricity.

Occult Force

So what is stray voltage? It is electricity lost as current flows through wires or any other source of resistance, including ground rods. One technical term for it is neutral-to-earth voltage.

Sometimes this leakage is excessive because of dairy-farm automation. A farmer who installs pipeline milkers, silo unloaders and manure sweepers may be overloading his farm's electrical system. That system may be antiquated anyway, or machinery may be poorly grounded.

Telephone wires also can be the source. So can a neighbor's house. A perplexing case at one farm eventually was traced to a mobile home more than a mile away. The voltage traveled back up the neutral wire at the mobile home to the utility's distribution line and then leaked out of the line's neutral wire at the farm.

Even damp cobwebs on an electrical service panel can retain a jolt of electricity, awaiting an unsuspecting victim's touch. When it comes to stray voltage on the farm, says Alan Lefcourt, a biomedical engineer for the U.S. Department of Agriculture, "there's no single cause—there are many."

On Your Toes

These leaks are usually too minute for human beings to detect, although not always. Bob Levy, a Kewaunee farmer, claims he feels stray voltage in the barn and at times in the bath. "It's like a sting," he says. "Sometimes when I'm in the barn it puts my toes to sleep."

Experts believe the voltage sometimes affects confined farm animals other than cows, unsettling hogs and interfering with hens' laying. But it is cows that really feel the charge. Mr. Levy says his have been doing Fred Astaire imitations: "We put some heaters in one stall and they just danced."

Milk cows may be as much as 50 times more sensitive to electrical phenomena than people are, says Ronald Gorewit, an agriculture professor at Cornell University in Ithaca, N.Y. A milking parlor with mechanical paraphernalia, damp floors and perhaps flimsy wiring is a minefield for a cow. She may lurch between potential shocks, shoving her wet nose into metal feed and water cups or bumping into pipes while electric motors spew out stray voltage that her damp hoofs attract.

Then she has to subject her anatomical splendor to the milking machine's suction cups; if the machine isn't grounded correctly, that can indeed be an unnerving experience. Wayne Paral, another Kewaunee dairy farmer, says that after his cows had a brush with stray voltage in his barn, they wouldn't come inside without prodding during a rainstorm.

It would seem to be a case for the Stray Voltage Research Council. Some of the nation's largest dairy cooperatives, milking-equipment makers, rural electric co-ops and utilities set up the council to explore the phenomenon's causes, consequences and possible cures.

For their part, electric utilities often put the blame on poor installation of equipment. A farm's wiring may be so old or badly grounded that voltage levels are abnormally high, they say. "Typically, that means that Joe Blow's brother-in-law has done the wiring."

Please Turn to Page 11, Column 1

Something in the Air Has Nervous Cows Doing a Barn Dance

Continued From First Page

ing," says a Wisconsin Public Service Corp. official, who notes that electricians in Wisconsin aren't licensed by the state.

Scientists don't deny that a dose of voltage can leave Ebbie out of sorts, but they aren't sure how big a factor this is in overall milk production. Prof. Gorewit of Cornell says his tests show that stray voltage can discourage cows from eating or drinking properly if they get zapped at the trough or tank. But after wiring cows with electrodes and randomly shocking them for four days, he didn't find any change in milk production.

"They were chewing their cud and didn't even react after a while," he says. In his view, the notion of stray voltage is "a hatrack to hang everybody's problems on."

One group that isn't about to settle the issue is the American Dairy Association. "We're not an opinion-giving association," a spokesman for the group says. "We're unaware of the problem, and if we were aware, it wouldn't be our position to have a position."

Farmers who have seen their milk production fall off aren't so timid. One farm couple recently won a \$343,000 judgment against Public Service Co. of Indiana over stray voltage, a judgment that is on appeal. A rural Minnesota jury awarded \$45,500 to a dairyman who contended that his power co-operative should have warned him about the potential dangers. (The co-op says it too may appeal.)

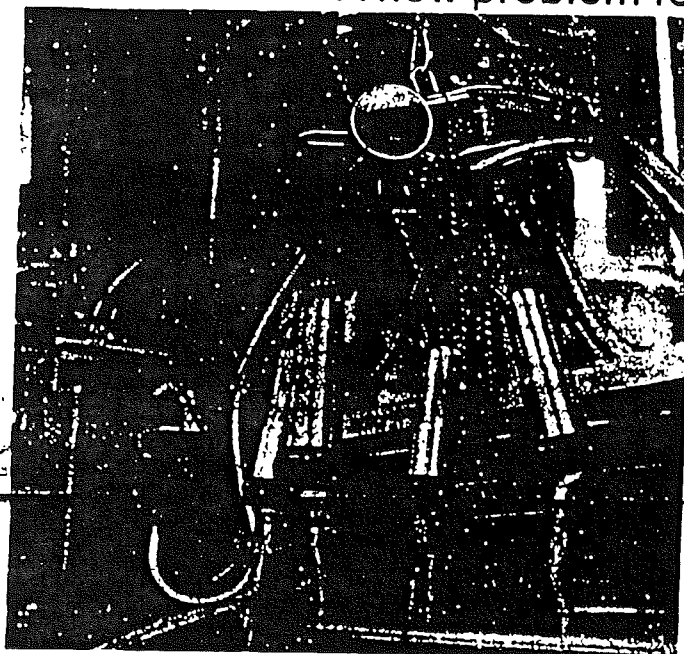
One Wisconsin farmer says stray voltage ruined his herd's sex life, forcing him to send to market some cows that couldn't be bred. He has filed a \$9 million damage suit, naming his utility, the maker of his milking-parlor equipment, a self-employed salesman for the manufacturer, his electrician and the electrician's insurance company. Insurers expect many more such suits. "It's the deep-pocket theory of law," contends a National Rural Electrical Association spokesman.

Meanwhile, Henry Tachick is tinkering with a solution. Mr. Tachick, a former General Electric Co. engineer, got Wisconsin Public Service to help him fashion a small gray box that hangs on a farmer's power pole and is supposed to intercept stray voltage before it can seek out unsuspecting cows. It's called a "neutral isolator," and it costs \$500.

The Stangels have one, and they think it is working. The only thing that annoys Mrs. Stangel is that they had to pay for it. Why not the utility? she asks. After all, it's their electricity.

Monday, November 12, 1984

Stray Voltage: A new problem for the dairy farmer



By Valerie Schmidt

Your dairy cows may be getting the shock of their lives!

What is worse, you are probably not even aware of it unless it has caused problems with your dairy herd. What is it? While stray voltage has had a lot of publicity in the last few years, less than 50 percent of dairy farms tested proved to have a problem severe enough to be corrected. It was also noted that a percentage of these could be corrected by the farmer either replacing faulty equipment or electrical wiring.

According to power supplier spokesmen, all farms probably have some stray voltage, less than .1 volt, which will not effect the dairy cow. "It is totally natural to have some stray voltage as some comes from the farm neutral as well as from the power company's neutral," says Don Lundquist, of Runestone Electric Association in Alexandria. "And that is perfectly normal and how it should be. It follows all the laws of electricity."

When and why is stray voltage a problem for the dairy farmer? First, the term stray voltage is a misnomer, but as officials within the power suppliers have noted that even a hundred years from now this phenomenon will be known as stray voltage. Other terms include tingle voltage, transient voltage, neutral-to-ground, and neutral-to-earth (N-E) which is the most correct. Transient voltage indicates here today, gone tomorrow, or may be insignificant at one time and keeps building. In some cases this may be the actual experience.

It becomes a serious problem when N-E voltages exceed 1-1.5 volts and gains access to the dairy cow through her stanchin, feedway, drinking cups or milking equipment. A person is unable to sense this low voltage. However, cows are extremely sensitive to even this low level of electricity.

As a dairy farmer, how can you determine stray voltage may be a problem with your dairy herd? There are several problem areas in which you should give careful analysis before contacting your veterinarian or your electrical supplier.

Probably the first thing a dairyman will notice is uneven milk out if the problem is not very severe. It is thought this becomes more frequent with cows according to the severity of the problem. Because of the uneven milkout more time is required to milk.

In extremely severe cases, the dairyman will notice a hesitance on the cows entering the barn of milking parlor. Even after entering the cows may continue to dance and move continually in the stall in an attempt to evade the unpleasant sensation. Flies, for example, may cause nervous, dancing cows. Possible mistreatment of the animals may be another cause. These are only indicators there may be something wrong and should be checked out.

Increased mastitis will become another problem. "However," states Lundquist, "stray voltage does not cause mastitis. It increases the chance the cow will get mastitis because of the

stress she feels while being in contact with the stray voltage, if the bacteria is present."

"You take a person who works hard twelve hours a day for two weeks and spends some time partying at night and that person will be more likely to get a cold than the person who gets proper rest and works a regular eight hour shift each day."

Besides stress from sensing the unpleasant, the cows may eat less due to feeling the sensation when coming in contact with the feed area or drinking cups also causing them to drink less, causing a reduction in milk.

As a dairyman, what are your next steps? Probably after taking careful analysis of nutritional intake and water quality available to determine if there are any changes to be made, you may wish to talk to your veterinarian.

"First," according to Kenneth Schmalz, spokesman for Otter Tail Power in Fergus Falls, "contact your electrical supplier and maybe even your electrician. Remember, improperly working electrical equipment can be as much a cause for stray voltage as the usual N-E, and may be even causing the problem. We advise that the farmer work closely with us while we are testing."

The testing requires the use of a voltmeter. Both REA and Otter Tail will test at the farmer's request. The testing time required will be different from farm-to-farm. Sometimes the problem can be isolated in one or two days, and sometimes it may require a week or more.

After isolating the problem, one of the following things can be done to correct the situation. After correcting measures have been taken the testing will be done again to determine if the proper cause has been corrected or if another problem area may still require attention.

It is possible to manage with stray voltage. "I know one farmer," says Schmalz, "who does manage his dairy cows with a fairly severe problem, however he has determined the cause and works around it. For many this may not be a workable solution or should it be. Correction may be called for and should be done."

The next possibility is elimination. Elimination is possible in less than 1 percent of the situations. "Sometimes we've learned it's a spider web and even an icicle caused a fairly severe problem for one farmer. Getting rid of that icicle or the spider web can get rid of the problem," said Schmalz.

Both Schmalz and Lundquist agree another problem can be faulty electrical equipment or wiring. Where these are creating a problem, a farmer should be aware that any shorts in the electrical systems on his farm may be deadly to himself, family, or animals who may come in contact with it.

Also stray voltage may not be coming from either the farmer or the power supplier. "I know of one case," said Lundquist, "where a faulty submersible pump on another farm some distance away was the problem. With that corrected, the farmer no longer had a problem."

Up until March, 1984, the only way REA could solve a problem of stray voltage was by using the isolation transformer. Otter Tail Power performed the use of the spark gap which is put inside the transformer, which was cheaper for the farmer. However, now REA is recommending and using in many cases a resistor which has been found to be very effective and also cheaper. Otter Tail is also using these in some instances.

Rather than installed on the ground as the isolation transformer is, this small device is installed on the transformer pole and connected to the transformer. It is a relatively simple but corrects the troublesome situation. It is also cheaper and appears to be far more efficient than the isolation transformer.

Lundquist believes it is the best device to control N-E voltage to date.

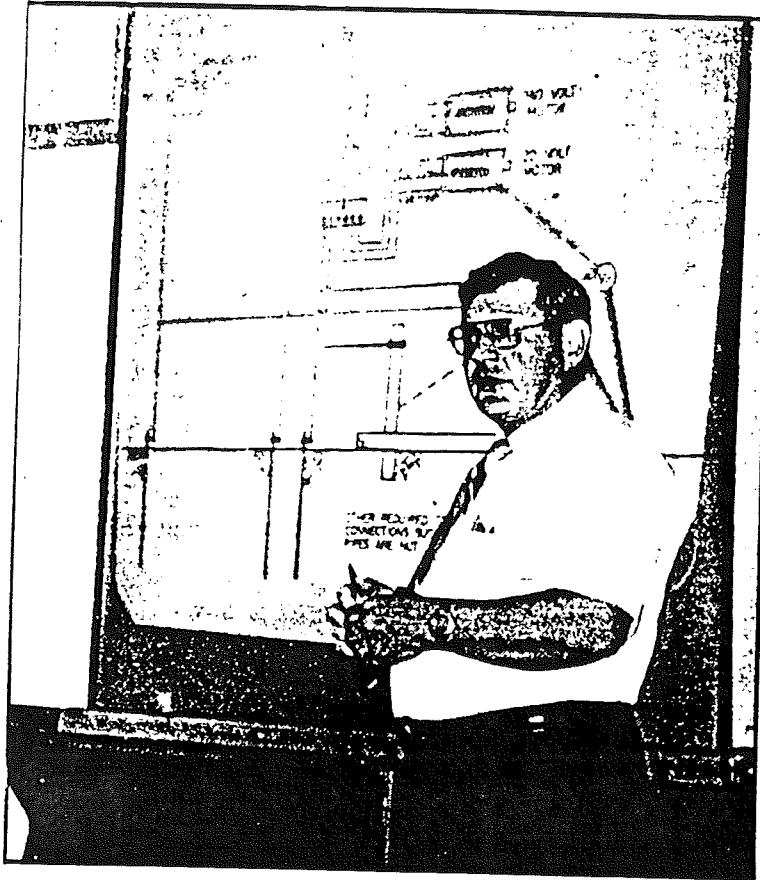
It must be remembered that farmers are not the only people who must control N-E voltages. Some businesses must control static electricity, for example. Hospitals, theaters, grain elevators, and gas stations, to list a few, must control either or both for safety. Hospitals find it necessary to curb static electricity, which is a high risk to them when working oxygen.

He also warns that farmers should make a serious effort to know the difference between N-E voltages and a short causing voltage in an area where no electrical appliance is being used or located. Any current a person can feel will possibly have had repercussions.

"I had a woman call in one day telling me she had a bad case of stray voltage. Her L.P. gas tank was so 'hot' it knocked her down when she touched it. What the problem was, was a mouse had gnawed an electrical wire bare under a mobile home. Even the sides of the home were hot. The electricity was traveling along the copper gas tubing to the tank."

These occasions are rare, but should not be overlooked, and are not to be confused with N-E voltages, which cannot be felt by a person. If someone senses there is a strong current in an unusual place, don't investigate it yourself. Electricity is certainly the farmer's friend when controlled and used properly, however, when controlled, misused or not respected, it will mean lower profits to the dairy farmer by N-E voltages, and also can mean a higher electrical bill is misused. In the case of shorts in malfunctioning electrical equipment, not only can a higher light bill result, but even death.

New Flashes-June 1981



HAROLD A. CLOUD

Stray voltage meetings held

A series of "Stray Voltage" informational meetings were held May 30, 31 and June 1, 1984. Dr. Harold A. Cloud, Extension Engineer from the University of Minnesota, discussed potential sources and solutions for stray voltage in dairy facilities. Dr. Robert D. Appleman, Extension Dairyman from the University of Minnesota, discussed potential behavior effects of stray voltage in the dairy herd.

Informational meetings were held in Fergus Falls, Wadena and Alexandria, Minnesota. The meetings were sponsored by the University of Minnesota Agricultural Extension Service in cooperation with Lake Region Co-op. Electrical

Association, Todd-Wadena Electric Cooperative, Runestone Electric Association and Otter Tail Power Company. Total attendance for all three meetings was about eighty and included dairymen, veterinarians, electricians and dairy industry representatives.

Dr. Cloud defined "stray voltage" a low level voltage on electrically grounded structures and equipment in close contact with a cow. He noted that "stray voltage" is known by other terms such as "tingle voltage" and "neutral to earth voltage". Another name sometimes used, but one that has an altogether different meaning among electrical engineers is "transient vol-

tage", said Cloud.

Dr. Cloud commented to those in attendance that just because a neutral to earth voltage of greater than one volt exists between the dairy barn neutral system and true earth (zero-potential earth), it does not mean there is a stray voltage problem. He stressed that a neutral to earth voltage will only cause a problem when it somehow accesses the dairy cow. To properly diagnose a stray voltage problem, you must determine how and where a neutral to earth voltage high enough to affect the cow is accessing the cow, said Cloud.

Dr. Appleman stated that voltage levels in excess of 0.5 volts which access the dairy animal cause behavior changes. Voltages that are continuous are less likely to cause behavior problems than those that are intermittent, said Appleman. It appears, Appleman said, that significantly higher stress levels are present in the dairy animal if it does not know when the electrical shock will occur.

If you were unable to attend one of the recent stray voltage sessions and would like information on the subject, the Agricultural Extension Service, University of Minnesota has published a bulletin entitled, "Stray Voltage Problems with Dairy Cows". A copy of this bulletin can be obtained by contacting your local County Extension Service Office. The solution to the stray voltage problem depends on a cooperative effort involving dairymen, researchers, electricians, and power suppliers, say Cloud and Appleman.

12/11/80

A shocking story

House seems to generate its own energy, ills

By Robert Engelman
Energy/Environment Writer

The three-bedroom ranch house looked like a bargain to Carl and Barbara Berkenpas in 1973. They bought it for \$18,000 and had it moved from an Air Force base in Minnesota to their 400-acre farm near Ashton, Iowa.

But life has been strange — very strange — for the Berkenpases and their two children ever since.

By now, they've involved everyone from the Iowa Health Department to the Kansas City office of the Environmental Protection Agency in trying to figure out what has attacked the family's health and why they can make a fluorescent light blub flicker by carrying it around the house in their hands.

A crew from the ABC television show "That's Incredible" is expected to head for Ashton, a town of about 400 in northwestern Iowa, in early January. "We're interested in the place as a haunted house and the fact that the family might be suffering from radiation sickness," said Bob Jaffe, the show's associate segment-producer in Hollywood.

On Jan. 16, Mrs. Berkenpas called William L. Brinck, director of the EPA's radiation program in Kansas City, hoping that he could tell her whether her house or her family was somehow naturally radioactive. Brinck says he doesn't think that's too likely, but he hasn't visited the house.

The fluorescent light bulb trick has been witnessed by outsiders, including Russell Currier, a veterinarian working on the case for the Iowa Department of Health. Currier, who calls himself a skeptic, noted that static electricity can excite the gasses inside fluorescent light bulbs and cause them to give off light.

"It flickers, really, but it's lit," Mrs. Berkenpas said. "Someone told us you could check for radiation from a microwave oven — we have one and thought it might be leaking — by wav-

ing a fluorescent bulb around it. So we got a bulb.

"It lit next to the oven — and everywhere else in the house, including the kids' bedroom. We tried to keep the kids from finding out about it for a while, but our son, Sean, saw it the other night, and he's started lighting

The light bulb isn't all that lights up unbidden in the house, Mrs. Berkenpas said. Two television sets in the family's den flicker so brightly some nights — although turned off — that "you don't even need to turn a light on to get through the room," she said.

She described other oddities in the house: buttons that appeared to melt, making pits in a plastic dish sitting on a bookcase; a string of Christmas-tree lights that shocked her husband even though the string of lights wasn't plugged in; visitors who have told the family that they feel strange in the house and can't stay.

But worse than the house's eerie quirks are the symptoms of collapsing health that afflict each family member in approximate proportion to the time he or she spends in the house.

"There's been a general deterioration in our health" over the years, Mrs. Berkenpas said. "We've undergone personality changes. Sometimes, I haven't been able to respond or react. I'd realize I should change Erin's diapers (the couple's daughter is now 7 years old), but I'd never do it. I was just totally out of it."

The situation has improved since 1977, when the family first sought professional help — and decided to spend as little time in the house as possible.

"We concentrate on being gone," Mrs. Berkenpas said. "Carl works outside most of the day, and I take the kids to catechism, Boy Scouts, basketball, guitar lessons, dance lessons, piano lessons. Anything to get out of the house."

Twice the Berkenpases have moved out, only to return because they couldn't afford two homes, and they depend on the farm for their livelihood. The land has been in Mrs. Berkenpas' family since her great-grandfather homesteaded it in the 19th century.

What is causing the problems?

Brinck said he was reluctant to get involved, because he knows from experience that it's next to impossible to reach the bottom of such environmental mysteries.

"My best guess is that there is something wrong with the electrical system in the house; something that sets up a permanent electric field," he said.

Currier said he was ready to give up on finding any answers; he's exasperated with the lack of measurable data on the house and the family's health troubles.

"Things are just too bizarre out there for me," he said. "There's only so much we can do. The lab work is in, and we've failed to come up with any determination or substance or phenomenon that's causing this."

"The house is not radioactive. We've come up with a big zero. So we've made a decision by default not to do any more."

Currier went to the Berkenpases' home for an afternoon himself last January, but he said he felt nothing abnormal there.

"I thought, 'Gee, my foot's getting numb.' Then I realized my legs were crossed. I uncrossed my legs, and there was no problem."

But Robert N. Corning, an industrial health specialist called in by the family, says he thinks that he has found the answer to the mysterious physical and psychological symptoms.

Corning, who works as a consultant for a division of SERCO Laboratories in Cedar Falls, Iowa, says the house is poisoning the family with arsine, a gaseous form of arsenic. He said that when he checked the house he discovered high levels of arsine and a colony of bacteria related to penicillin that eats arsenic-laden glue used in old books and antique furniture.

The Berkenpases collect old books and antiques, and the highest levels of arsine gas have been found in the house's den and living room, Corning said. He thinks the colony of bacteria attached itself to the house when it rested on concrete blocks at the Air Force base and then spread throughout the house after it was placed on top of a basement on the Iowa farm.

"Every symptom that Mrs. Berkenpas describes can be assigned to arsenic poison," Corning said.

Mrs. Berkenpas has taken Corning's advice as much as she can, swabbing every corner of the house with bacteria-killing disinfectant and improving ventilation. But neither she nor her husband knows what else to do to safeguard the family's health.

She said, "We're particularly worried about our kids, because they're going through their growing years, and arsenic is said to accumulate in the body. We're dealing with something we don't understand, and we're beginning to think that no one can tell us what's going on."

MOORE TWO.0 Oct 25 1988

THRESHOLD REPORT 3:36 PM

Type: Ind. channels

L N BARN THRESHOLDS (Channel 1)

Mode: AC
Surge voltage: 130.0 Urms
Sag voltage: 105.0 Urms
Impulse: 20 Vpk
High freq noise: 5.0 Vpk
High frequency: 61.2 Hz
Low frequency: 58.8 Hz
Wave shape: 20% variation
Minimum duration: 0.1 cycles
Line impedance: 50 ohms
Hysteresis: 1.0%

N G BARN THRESHOLDS (Channel 2)

Mode: NEUT-GND
Surge voltage: 5.0 Urms
Impulse: 20 Vpk
High freq noise: 5.0 Vpk
Line impedance: 50 ohms
Hysteresis: 1.0%

WB GTR C THRESHOLDS (Channel 3)

Mode: NEUT-GND
Surge voltage: 5.0 Urms
Impulse: 20 Vpk
High freq noise: 5.0 Vpk
Line impedance: 50 ohms
Hysteresis: 1.0%

SUMMARY REPORT INTERVAL: 3Hr

3 HOUR STRIP CHARTS

L N BARN Rms Voltage
L N BARN Impulse
L N BARN Hi Freq Noise
N G BARN Rms Voltage
N G BARN Impulse
WB GTR C Impulse

INACTIVE DISTURBANCES

L N BARN Hi Freq Noise
L N BARN Frequency
N G BARN Rms Voltage
N G BARN Hi Freq Noise
WB GTR C Rms Voltage
WB GTR C Hi Freq Noise

Internal UPS time: 5 minutes.

PAPER SUPPLY IS LOW.



the middle of the night, travels the back roads of the British countryside, and returns several days later. Each convoy consists of four 52-foot launcher vehicles, each carrying up to four missiles, two control vehicles, up to sixteen support vehicles, and a large police escort—all told, around 32 vehicles extending over a quarter mile.

Once a convoy leaves Greenham Common, the women of the peace camp start spreading the word that a dispersal exercise is in progress. This message is carried through the Cruisewatch network, ensuring that the exercises are never secret, as the military meant them to be. Because of this network, the cruise exercises have always been confronted with vigorous and continuous protest—along the convoy route (even to the point of stopping the convoy), at the launch site, and at Greenham Common itself.

Greenham protester and peace activist Kim Besly tells why the Cruisewatch network and encampment continue to thrive. "It's the women that provide the next generation, and women have always grieved in times of war. And I think what women are saying now is we're tired of providing the cannon fodder. There must be a better way."

ZAPPING THE WOMEN

Two things have changed dramatically, however, since the fall of 1984: many, if not most, of the women have become ill, and the massive police and army presence guarding the base has virtually disappeared.

The first physical symptoms the women observed occurred on October 15, 1984. On that day, the women noticed the same plane continuously taking off and landing. During this activity, the women noted that at particular points by the perimeter fence, many of them were getting headaches. But headaches were only the mild beginning to this story. It was much later, when a whole range of new and startling symptoms surfaced, that the women realized that something unusual was happening. They later recalled that in September 1984, one month prior to the first appearance of

Joseph Regna is a physician who works on public health, peace, and environmental issues in the Boston area.

symptoms, many new and different antennae had been installed at the base.

Greenham women have experienced both physical and psycho-emotional symptoms. The physical include vertigo, headache, earache, sensation of the eyes being pulled out, retinal bleeding, lisping and slurred speech, swollen neck glands, burnt face (even at night), dizziness, lack of coordination, nausea, vomiting, diarrhea, sleep disturbance, palpitations, pain in the ovaries and uterus, irregular menstrual cycles, and postmenopausal breakthrough bleeding. Psycho-emotional symptoms include lack of concentration, disorientation, loss of memory, depression, irritability, aggressiveness, lack of confidence, sense of loneliness, and a sense of panic in nonpanic situations.

Kim Besly is one woman who has experienced health problems at the Greenham women's peace camp. Although she describes herself as "a very ordinary mother and grandmother," Besly's symptoms of pain in the uterus and postmenopausal bleeding are anything but ordinary. Neither are those of her daughter, another camp protester, whose less frequent menstrual periods took a whole year to revert to normal.

But Kim Besly's hope remains as strong as ever. "Despite the mud and the barbed wire and the verbal abuse and so on, Greenham is a very special place and it draws you back," she says. "There's a kind of vision there that something good has got to come out of this."

The Greenham women report that the prevalence and intensity of the symptoms increase at specific points along the fence—particularly at Green Gate—at times when there are many women demonstrating, and when cruise missile convoys exit and return. Visitors to the peace encampment, both men and women, report experiencing the same types of symptoms and the same pattern of variation as do the Greenham women.

MEASURING MICROWAVES

Once they believed that a connection existed between what was going on inside the base and their symptoms, the women at Greenham enlisted the assistance of Dr. Rosalie Bertell, an authority on the biological effects of nonionizing radiation.

Bertell's measurements at Greenham showed strong electromagnetic radiative levels, including microwave frequencies that coincided spatially and temporal with the women's symptoms.

When a woman would say, "It's stror here," that's what the meter would show. When a woman would say, "It's not stror here," the meter would show that to. Once, when a convoy was leaving the base and the women noticed that base personnel saw that they were taking radiative measurements, the women figured that whatever was causing the symptoms was "switched off" because no one was doing anything.

Members of the British group Electron for Peace have confirmed Bertell's findings during their measurement activities. In fact, they found microwave levels to be 100 times more than background levels and concluded that since the radiation might be pulsed, their meter may have been recording an artificially low average value. These results, coupled with her experience, led Bertell to conclude that the symptoms women have been experiencing are consistent with exposure to low-level microwave radiation.

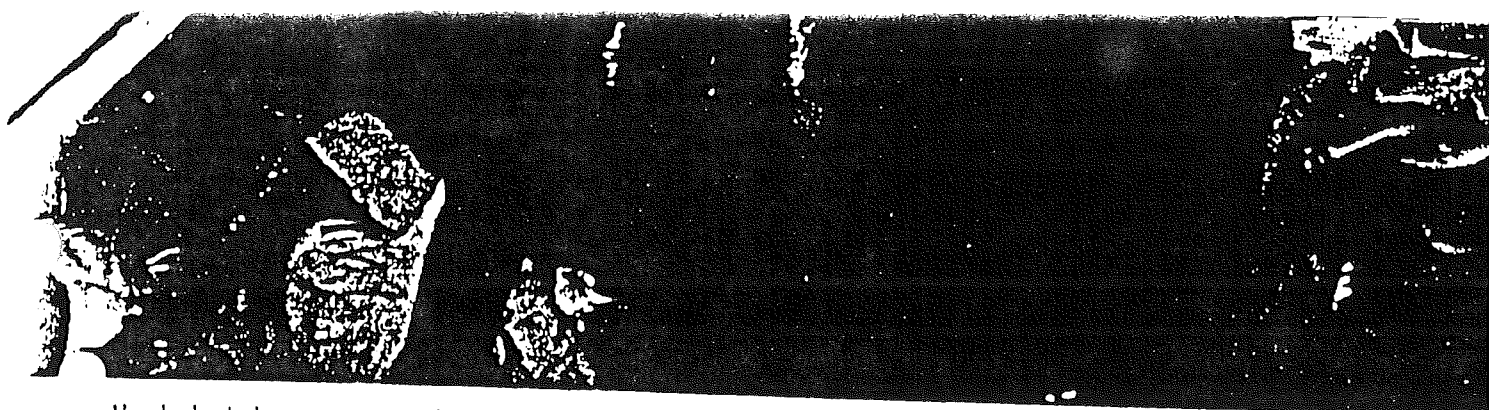
VIOLENCE AGAINST GREENHAM WOMEN

It would be a mistake to think that prior to the onset of the health problems, Greenham women's protests came without cost. Beyond the expected arrests, there have been physical attacks on women, searches, the extinguishing of camp fires in the middle of winter, and evictions, destruction of campsites and equipment.

Police brutality has been severe, and deadly: picking up and throwing individual women into groups of other women, driving police cars at high speed through groups of women, and physical abuse with apparent intent not just to scare, but to harm.

During one Cruisewatch exercise police seized one woman, Blue Joyce, dragged her into the back of a van with police. After the police had taken her, the van subsequently caught up and passed the convoy. One of the women recounted:

"The police then talked of 'excess baggage.' Next came the 'countdown' excess baggage: 10, 9, 8, 7, 6, 5, 4,



Photo/Boo Naylor

"—the back doors were opened and they tried to push Blue out of the still-moving van. But she resisted, clinging to the inside. So a policeman jumped out to drag her out, but the van was going too fast for him to keep up.

"After the van slowed down, Blue was dragged out and left lying in the road in a state of shock. The cruise convoy then approached with its police escort. The police vehicles swerved around Blue, not stopping. Just before the massive cruise vehicles bore down on her, Blue managed to crawl onto the verge. Much later, a passing car gave Blue a lift. She was still in a state of shock, vomiting continuously, and was taken to hospital."

With the police brutality and presence now markedly less than it used to be, it seems that the military has traded this more visible type of repression for the more politically acceptable and invisible punishment from microwave radiation. As Kim Besly observed, "It is easy enough to kill people. It is harder not to kill them but to stop them all the same. The principle is not really one of minimum force, but of minimum political reaction."

MICROWAVE EXPOSURE & SURVEILLANCE

Nearly a year after Dr. Bertell's spring 1985 Greenham visit, two British newspapers revealed what may be the crucial link in explaining the mystery behind the women's symptoms. *City Limits* claimed that the British Ministry of Defence is probably using its new intruder detection system CLASSIC (Covert Local Area Sensory System for Intruder Classification) around Greenham Common. The *Manchester Guardian* wrote that "the U.S. employs an intruder detection system called BISS (Base Installation Security System) which operates...on a sufficiently high frequency to bounce radar waves off a body moving in the vicinity of a perimeter fence." Both the British CLASSIC and the American BISS employ microwaves to detect anything that gets in their path.

Is what's happening to the women at Greenham Common an attempt to electronically subdue them, or the result of the use of radar surveillance? Is it deliberate, or is it incidental to the

CONTINUED ON PAGE 32

MICROWAVES AND THE MILITARY

The military has known for more than fifty years that microwaves are dangerous. As early as 1930, the U.S. Navy found that people who stood in front of antennae would experience discomfort, weakness, drowsiness, and headaches. The U.S. Air Force, in a 1955 study, discovered that standing in the way of radar beams caused ringing in the ears, buzzing-type vibrations, pulsations, and tickling around the head and ears.

Project Pandora, a 1965 study on chimpanzees done in response to the microwave bombardment of the U.S. embassy in Moscow, concluded, "The potential of exerting a degree of control on human behavior by low-level microwave radiation seems to exist." Richard S. Cesaro, the project's director, urged that the effects of microwaves be studied for "possible weapon application."

This recommendation seems not to have gone unnoticed. In 1972, the Pentagon admitted that the Army had, in fact, tested a microwave weapon, what it called an "electronic flame thrower." Also in that same year, a U.S. Army Equipment and Research Center study, "Analysis of Microwaves for Barrier Warfare," stated that it was possible to field a truck-portable microwave barrier system that would completely immobilize people in its path.

Whether such a device or one of its technological offspring has ever been used is not certain, but the utility of such an approach to control people almost precludes the possibility that usage has not occurred. Robert Becker of the Syracuse, New York Veterans Administration Hospital put it this way in a 1985 interview: "If energy we can't see, feel, smell, or taste can wreak havoc with our immune systems and even upset brain chemistry, it would seem to be the ideal

weapon."

Adding credibility to such speculation is the startling assertion by Eldon Byrd, a researcher with the Naval Surface Weapons Center in Silver Spring, Maryland. "Between 1981 and September 1982 the Navy commissioned me to investigate the potential of developing electromagnetic devices that could be used as nonlethal weapons by the Marine Corps for the purpose of 'riot control,' hostage removal, embassy and ship security, clandestine operations, and so on," Byrd stated.

There is evidence that the U.S. government has already used "energy we can't see, feel, smell, or taste" against people it regards as enemies. For example, the U.S. employed ultrasound in Vietnam to disorient and demoralize the Vietnamese people. Specifically, the U.S. used a device known as the "squawk box" or "sound curdler," which produces a scientifically designed shrill, shrieking noise in the ultrasonic range and causes people to experience nausea, giddiness, permanent impairment of hearing, and mass psychological distress in crowds.

A report in *Electronics Today* in December 1985 stated that police forces in the U.S. have carried out trials with infrasound generators mounted on the back of trucks. In addition, police forces in Britain have been known to use a device called a "photic driver," a glorified strobe light that causes giddiness, nausea, fainting, and epileptic seizures in those exposed. After 1983, a form of the photic driver, the Valkyrie, and other so-called frequency weapons were completely eliminated from the British Defence Equipment Catalogue, though all were still in use, at the request of the British Ministry of Defence.

MICROWAVES

CONTINUED FROM PAGE 23

operation of the base? But this may be an irrelevant distinction, because either way, if the government is using microwaves or other invisible means of security and control, it must be doing so intentionally and it must be aware of microwaves' potential for harm. (See the accompanying sidebar.)

Beyond this inclination to place fault lies the larger issue of exposure to unnatural forms and levels of electromagnetic radiation and the effects those exposures have on most of us in the industrialized world. Electromagnetic radiation is ubiquitous, from police radar and television transmitting towers to high-tension power lines, VHF radio antennae, and CB radios. For microwaves and radar specifically, the U.S. exposure limit of 10 milliwatts per cubic centimeter (1,000 times the Soviet Union's standard) was set not to ensure health and safety, but to allow the military high enough levels for virtually unrestricted use of microwaves and radio waves.

In addition to the symptoms experienced by the Greenham women, microwaves can also cause cataracts, miscarriages, birth defects, leukemia, hair loss, decreased life expectancy, anemia, tremors, diminished sexual vigor, loss of appetite, sweating, suppression of the immune system, polycythemia vera (a rare blood disorder); heat stroke, decreased sperm production, increased permeability of the blood-brain barrier, meningitis, and brain tumors. With many cases currently in litigation, 25 former U.S. military personnel have already been granted compensation for injuries suffered as a result of exposure to microwaves and radar.

NUCLEAR HEGEMONY VS. BRITISH SOVEREIGNTY

But the danger of microwave radiation to all people is not the only issue on which the Greenham women's struggle has focussed attention. Another is the sovereignty of Great Britain. With over 102 U.S. military bases in Great Britain, it is small wonder that the British often feel as if they're living in an occupied country.

Other irritants bolster this feeling. For example, U.S. soldiers have participated in the repression of the women's activities at Greenham Common: making arrests, using abusive language, and wielding batons to crush women's fingers as the latter tried to cut or unravel the fence. When some Greenham women asked a British soldier why he was guarding a foreign military power's nuclear weapons base on British soil, he replied, "To be honest with you, the sole reason we are

here is not to keep you from them, but more importantly to keep them from you."

In addition, people arrested on the grounds of U.S. bases are prosecuted for trespass under U.S. law, with stiffer penalties than exist under British law. The U.S., in the event of war, has the right to shoot anyone entering one of its bases without permission and would not be liable to the British people for any of its actions. As a draft U.S.-British Status of Forces Agreement states:

"Should the U.S. military commander consider that the U.K. government does not possess the capability of quelling disorders which may materially affect the mission or security of the U.S. forces effectively or in time, the U.S. forces may take such action as the U.S. military commander deems necessary, either unilaterally or in cooperation with the government...no civil action shall be brought in the courts against any member of the U.S. Forces....The authorities of the U.S. shall have the exclusive right to exercise criminal jurisdiction."

In the event of a crisis, 100,000 U.S. troops could pour into Britain, outnumbering British forces three to one. Civilians could be compelled to work in labor gangs and be at the disposal of the U.S. military. Up to 30 hospitals may be ordered to discharge all civilian patients to make way for U.S. military casualties, and even today, with the British health system in need of major renovation, the U.S. has decided to build 16 military hospitals for the exclusive use of Americans in Great Britain.

But then, Great Britain's sovereignty, most Greenham women would agree, is not the real issue either. The existence of nation states and the national security mentality that they engender is the underlying problem. It is in this context—the struggle against two occupying forces, their "own" government and that of the U.S.—that the efforts of the Greenham women and the British people take on their real significance.

Their struggle is unique to, and yet part of, the larger struggle for freedom, democracy, and people taking control of their own lives. With all of its technological arsenal, from photic drivers and squawk boxes to nuclear bombs and cruise missiles, the state is defenseless against the hope wielded by a people determined to resist.

"One can look at all this and feel that it's very, very depressing, but my feeling is that I believe that people are going to change it," says Simone Wilkinson, a longtime Greenham activist. "I believe it absolutely, and that's the strength that I found through being at Greenham." 9

Farmers learning risks of stray voltage

Marty Moylan
Staff Writer

Something was bothering Arlen Burke's cows. And it was close to living the third-generation Arlen, Wis., dairy farmer out of business.

At one point, milk production on his 65 dairy cows was down 50 percent. He tried one hopeful remedy after another. But it took him almost three years to find the problem and another three to fix it. His cows were getting a slight electrical shock — about one volt — when they came in contact with milking machines and water cups.

The problem was stray voltage, a low voltage that exists on grounded electrical equipment and metal objects used as grounds. Some stray voltage is inevitable in a grounded electrical system. But when it reaches or exceeds half a volt in a dairy barn, it may shock and harm their health and reduce milk production.

Burke said not many Wisconsin dairy farmers were aware of stray voltage in 1982, when he encountered it on his farm. But they are now. And the state is addressing their concerns about it.

"It can get to the extent where you're talking about someone's livelihood, which is a very serious issue," said George Edgar, a member of the Wisconsin Public Service Commission. "An unsolved or unchecked stray voltage problem could put a person out of business."

Edgar's commission and the State Agriculture, Trade and Consumer Protection Department have organized a 26-member committee, the Stray Voltage Task Force, to look into the problem.

The committee is holding 14 hearings around Wisconsin — one session was held last week in Rice Lake — to learn more about the extent of the problem and to determine what can be done about it. It hopes to issue a report in mid-November.

Minnesota already aware

In fighting stray voltage, Minnesota got a head start on Wisconsin.

"We started to work on the problem ten years ago," said Harold Cloud, a University of Minnesota specialist on stray voltage. "Generally speaking, things in Minnesota are under better control now."

Most Minnesota farmers are aware of stray voltage, and electric utilities are usually very cooperative in working with farmers to reduce it, according to Bill Coleman of the Minnesota Department of Agriculture.

"There are some farmers out there that don't realize they have stray voltage, or it isn't a big problem for them," Coleman said. "All a farmer with a stray voltage problem has to do is contact his power company or the extension service at the university campus in St. Paul. There's somebody there that will help them out."

Stray voltage can be reduced to less than one-tenth of a volt, but it cannot be eliminated, according to Tom Nigon, an engineer for Northern States Power Company-Wisconsin.

Troublesome levels of stray voltage generally are caused by inadequate grounds and insulation, poor wiring and electrical connections, electrical shorts, and unbalanced loads on two 120-volt lines split off from a 240-volt line, Nigon said.

When a cow touches a metal drinking cup, milking machine or other object that has stray voltage in it, current will pass through the cow to ground. If the voltage is high enough, the cow will get a shock.

"The mouth is the most sensitive part of the cow," said Duttee Holmes, a consulting engineer for NSP-Wisconsin. "And its rear hoofs are back in the gutter, where you have manure and urine which makes the concrete wet."

Effects debatable

How much of an effect stray voltage has on dairy cows is a subject of debate. "Everyone has a different opinion," said Nigon. "There are researchers who will say it has a minimal effect on production. Of course, other people in the field and the producers themselves say it has a lot of effects."

"The cow becomes nervous because of stray voltage, and when the cow is nervous it indirectly can lead to other problems," he said.

"Stray voltage can be catastrophic to a dairy farmer," said Cloud, a professor of agricultural engineering. "It really can. But it can be corrected."

The source of the problem can be on the utility's side of the power connection, the farmer's side or on both sides, Nigon said.

Tom Beane, a Fort Atkinson dairy farmer and a member of the Stray Voltage Task Force, agreed. "I'd say it's a 50-50 problem," he said. "It's very hard for some people to admit that, though."

Some farmer-utility stray voltage disputes have gone to court. Beane estimates 20 have been settled and another 100 may be pending. He said out-of-court settlements are common.

Identification difficult

Identifying and solving a stray voltage problem can be time-consuming, frustrating and expensive, said Burke, who estimated it cost him about \$200,000. For almost three years, he suspected virtually every other potential cause for his cows' lowered milk production.

Veterinarian bills piled up, as he sought a solution. He tried everything from new feed mixes to having only one person milk the cows, on the theory that too many milkers could make them nervous.

The cows still kicked, danced and fidgeted. "They didn't want to drink or eat and they didn't want to be milked," Burke said. "I knew if it continued, we'd be out of business."

Once Burke discovered the low level of electricity in his dairy equipment, he had to go back and forth with his local power company, arguing over who was responsible for it. He rewired his barn — three times. The electric company replaced a transformer on its line

and did other work. Burke said he finally got his stray voltage problem in early 1986, and soon his cow producing record amounts of milk.

The difficulty with stray voltage is that the problems it causes cows may also be caused by other things, Nigon said. In short, farmers may mistake and believe stray voltage is causing the problems.

Stray Voltage In Livestock Operations

STRAY VOLTAGE

As farms have become more electrified over the years, a previously little-known condition has grown to serious proportions in some dairy, swine farrowing and similar operations. The term commonly used to describe the phenomenon is "stray voltage." A small electric potential (voltage) exists between grounded neutral and earth on any electric system. This voltage will also exist on conductive objects that are connected to the electric system neutral for safety in the event of a fault. These voltages are usually too low to be felt by humans due to the insulation effect of skin, shoes, etc., and perhaps a higher natural tolerance. Suckling pigs and dairy cattle are, however, very sensitive to extremely low voltages because of natural low tolerance and the type of contact (tongue and teat-end contact, for example) with the conductive objects. The special and critical aspects of livestock contacting these low voltages that normally exist should be considered in all dairy, swine farrowing and similar operations.

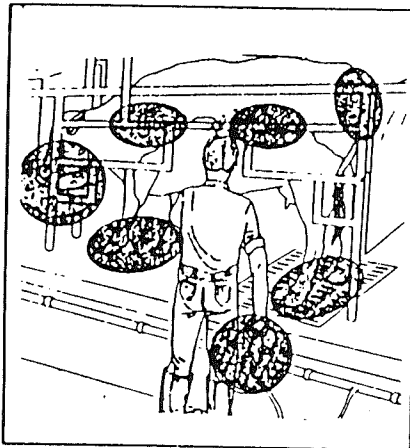
SYMPTOMS

Since most research has been done on dairy farms, we shall discuss these installations. How does a dairy operator determine whether or not a problem may exist? The University of Minnesota Agricultural Extension Services lists seven symptoms and stresses that animal reactions will vary based on the severity of the problem.

1. Uneven milk let-down: This is the most common symptom expressed by dairy operators. The number of cows affected and the severity of the milk let-down problem appear to be dependent on the level of stray voltage present. When milk let-down is uneven, longer milking times become apparent and stripping is necessary.

2. Cows extremely nervous while in the parlor: This trait is often characterized by the cows dancing or stepping around almost continuously while in the parlor stall. However, dairy operators are reminded that

cows may become nervous for other reasons, such as malfunctioning milking equipment or rough handling by the operator.



3. Cows reluctant to enter the parlor: When cows are subjected to stray voltages in the parlor stalls, they soon become reluctant to enter the parlor. In extreme cases cows have had to be driven into the parlor and there is a tendency to "stampede" out of the parlor upon release. But again, this symptom is not specific since cows may be trained to expect the parlor operator to chase them into the milking stalls.

4. Increased mastitis: When milking is incomplete, more mastitis than normal is likely to occur. All that is required is the presence of infectious bacteria. This, in turn, will result in increased somatic cell count.

5. Reduced feed intake in the parlor: If cows detect stray voltage while eating from the grain feeders, a reluctance to eat and reduced feed intake is almost certain to occur.

6. Reluctance to drink water: Stray voltages may reach the cows in stall barns through the water supply or metal drinking cups. Thus, cows soon become reluctant to drink.

7. Lowered milk production: Each of the symptoms described previously is associated with stress, reduced nutrient intake, or disease, and therefore, a drop in daily milk production is to be expected. Even when the stray voltage problem has been corrected, milk production may remain abnormally low for a while because of the associated problems.

EVALUATION

It must be noted again that many other factors may contribute to the above symptoms. A careful evaluation of all possible causes is necessary and will lead to the earliest possible resolution of the problem. This evaluation should include consideration of problems with equipment, disease, nutrition, etc. If stray voltage is suspected, initial assistance may be obtained from your electrician. We can also provide additional

information that may be of assistance. Veterinarians, equipment dealers and creamery field representatives are also becoming more familiar with stray voltage and may be able to help.

NEW CONSTRUCTION

If you are considering building or remodeling your dairy or similar facility, an ounce of prevention is worth a pound of cure. New facilities can easily and economically be constructed to avoid future stray voltage problems. The University of Minnesota Agricultural Extension Service has excellent publications on stray voltage available through your local county agent.

EXISTING CONSTRUCTION

Once stray voltage has been identified and measured, there still remains the problem of a solution. It is possible to alleviate stray voltage problems in existing facilities. Again, information is available from the University of Minnesota, your county agent and Red River Valley Cooperative.

OFFICE ADDITION NEARING COMPLETION



Construction of the addition to the Red River Valley Cooperative Power Association office is nearly completed. Tentative plans are to move into the new space in mid-November. Mr. Meter

Detection of 60-Hertz Vertical Electric Fields by Rats

Philip M. Sagan, Mark E. Stell, Guy K. Bryan, and W. Ross Adey

Research Service, Jerry L. Pettis Memorial Veterans' Hospital (P.M.S., M.E.S., G.K.B., W.R.A.) and Department of Physiology and Pharmacology (P.M.S., M.E.S.), and Department of Surgery (W.R.A.), Loma Linda University, Loma Linda, California

Rats were trained to press levers to indicate the presence or absence of 60-Hz vertical electric fields at intensities from 0 to 27 kV/m (rms). The probability of detecting the field increased as the strength of the field increased. The shape of the detection curve (psychometric function) for most subjects (Ss) was similar whether the discriminative stimulus was the electric field or a tone. Two protocols were used to estimate the minimum field intensity necessary to detect the field (*Reiz Limen, RL*). The RL was estimated to be 13.3 kV/m (rms) when using one protocol (the staircase method) and 7.9 kV/m (rms) when using another protocol (the method of constant stimuli).

Key words: 60-Hz electric fields, behavior, psychophysics

INTRODUCTION

This experiment sought to establish the existence of a relationship between 60-Hz electric fields and sensory responses. Rats were required to regulate learned behavior on the basis of the presence or absence of a field. Another laboratory that used a different protocol [Stern, et al, 1983; Stern and Laties, 1985] reported that rats could detect electric fields at field strengths between 3 and 10 kV/m (rms). Their studies showed that the reported detection was not caused by any of several possible confounding variables. Cooper et al [1981] and Graves [1981] reported that pigeons were able to detect electric fields at 21 kV/m but not at 10.5 kV/m. The present study re-examined the rats' ability to detect electric fields when using different behavioral techniques. Two different behavioral protocols were employed in order to compare the threshold estimate of each. Also, the present study sampled many intensities around the threshold of detection to reduce interpolation errors. Finally, detection of a well studied sensory stimulus (sound) was compared to detection of electric fields.

The sensory effects of electric fields were measured by using the methodology of signal detection theory and animal psychophysics [cf Green and Swets, 1966]. Sensory behavior was selected because it is one of the simpler behaviors to which the central nervous system contributes, and because it includes examples of the most

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TABLE 2. Absolute Electric Field Thresholds by 5-d Period (kV/m, rms)

5-d period	Experiment I: staircase (n = 16)	Experiment II	
		Staircase (n = 8)	MCS ^a (n = 8)
1			
Mean	15.61	11.59	7.34
SD	3.39	3.59	4.23
2			
Mean	14.77	11.35	7.70
SD	3.79	3.40	4.45
3			
Mean	13.19	14.49	9.37
SD	4.86	4.39	6.23
4			
Mean	13.49		8.10
SD	4.18		3.89
5			
Mean	11.64		7.25
SD	6.08		3.22
6			
Mean			7.57
SD			2.84

^aMCS, method of constant stimuli.

The major findings of this experiment were: First, rats could regulate learned behavior in such a fashion that certain behaviors, reinforced only in the presence of the field, were most likely to occur when a field was present. Other behaviors, reinforced only in the absence of the field, were most likely to occur when the field was absent. This demonstrates that rats did detect 60-Hz vertical electric fields. Second, the accuracy of the behavioral performance was correlated with the magnitude of the field. This suggests that the changes in sensation associated with changes in electric field intensity did produce a prothetic continuum, and that measurement of the psychophysical function and RL was possible. Third, fields of sufficiently low intensity were not detected. Therefore, the absolute threshold (RL) for fields could be defined. Fourth, the performance of many of the S's remained constant whether they were discriminating auditory intensity or electric field intensity. Thus, electric fields of these strengths did not disrupt stimulus control of behavior. This, in turn, meant that the tools of behavioral analysis were applicable.

Currently there are two studies that report a minimum detectable electric field threshold (RL) for rats: Stern et al [1983] and Stern and Laties [1985]. These studies employed a behavioral protocol that had both similarities and differences with the protocol used here. For example, their protocol tended to bias the rats to slightly over-report the presence of the field. This is because Ss had only two levers, one to initiate a trial and the other to report the presence of a field. Correct reports (when the field was present) were reinforced. Incorrect reports (when the field was absent) were mildly punished (by turning off the ambient lighting and preventing trial initiation for several seconds). Since the Ss could only obtain a reinforcement by pressing the report lever, they tended to slightly over-report the field. Stern and coworkers corrected for this by using the formula $P_{\text{corrected}} = (P_{\text{field}} - P_{\text{nonfield}}) / (1 - P_{\text{nonfield}})$, where P is the proportion of report responses during field

when they are detecting tones. Our two behavioral protocols produced average threshold estimates (RLs) of 13.3 and 7.9 kV/m (rms).

ACKNOWLEDGMENTS

We gratefully acknowledge the help of M. Misakian for calibration measurements of one test chamber and for advice regarding the use of his probe technique. We are also grateful to F. Dietrich for insightful comments and suggestions on the electric field exposure apparatus. Finally, we wish to thank W. Kaune who was of great assistance during the development of the apparatus.

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Health & Environment

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Feature Article

AC Electric and Magnetic Fields: A New Health Issue

Over 300,000 miles of alternating-current (AC) transmission lines stretch across the U.S. landscape, operating at voltages that range from 115 to 765kV. The voltage creates a 60 cycle/second (60Hz) electric field between the overhead conductors and ground; a 60Hz magnetic field is also present whenever current flows. The existence of these fields has raised speculation that power lines may affect health.

Both electric and magnetic fields (EMF) transfer electrical energy to conductive objects, including humans. But even in a 10kV/m electric field—about the maximum under an operating 765kV line—the current that flows through a person to ground is small: less than 200 μ A. Magnetically-induced currents are typically an order of magnitude less.

Early research on health effects emphasized electric, not magnetic, fields because most induced body current under a power line results from the electric field. Recently, however, there has been rising interest in magnetic and combined electric-and-magnetic fields. This has been stimulated mainly by a small body of epidemiologic research reporting an association between low-level background residential AC magnetic fields and childhood cancer.

What's the evidence?

First, extremely-low-frequency (0-300 Hz) EMF can affect cells and tissues *in vitro*. The biological responses seem sensitive to the field's magnitude, waveshape, and

frequency. Interactions appear to take place at the cell surface, perhaps acting on receptor sites and altering ion or molecule transport across the membrane.

Chronic exposures of laboratory animals to 60Hz electric fields elicit some behavioral, neurophysiological, and endocrinological effects. AC magnetic fields appear to have some neurophysiological and behavioral effects; most seem completely reversible. There is also some evidence of resonance between the earth's magnetic field and AC magnetic fields. If valid, this finding implies that effects may depend on the local strength and orientation of the earth's magnetic field.

A number of epidemiologic reports conclude that elevated residential and workplace electrical environments may increase cancer risk. Unfortunately, these studies have all been based on surrogate indices for historic exposures, such as job title, and spot measurements or nearby power line wiring configuration for residential studies. As yet, researchers haven't been able to identify any plausible mechanism for EMF interactions with biological tissue. Nor are there convincing laboratory findings to validate the cancer hypothesis.

N.Y. study shifts research focus

Over the past decade, several scientific advisory panels have reviewed this growing body of data. They have generally acknowledged EMF biological activity, but con-

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by Robert S. Banks, M.P.H., P.E.
Publisher & Senior Editor
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cluded that a public health hazard is unlikely. In July 1987, New York State's Dept. of Health published the latest of these consensus reports, the culmination of five years' work by the New York State Power Lines Project.

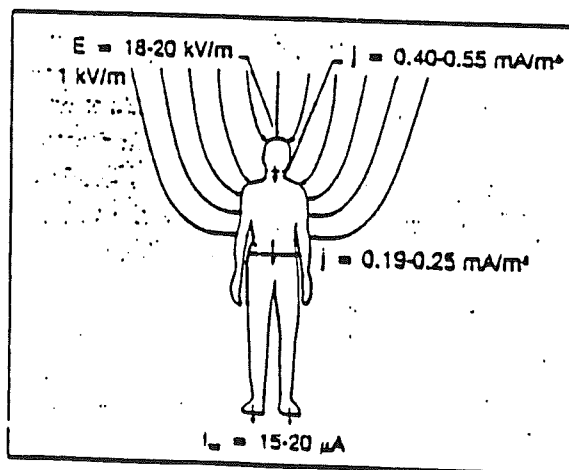
The report's first recommendation is a dramatic change from earlier scientific opinion. Specifically, it recommends research into ways of reducing chronic low-level residential AC magnetic field exposures from sources near homes: primary distribution lines, distribution transformers, low-voltage secondary distribution lines, service drops, and neutral current flow in grounded plumbing systems. This suggestion clearly shifts the EMF health effects issue away from high-voltage transmission lines, where the controversy has been focused for 15 years.

What's the public perspective?

We now have at least a major perceptual issue—if not a *bona fide* public health problem—with AC electric and magnetic fields inherent to the transmission, distribution, and consumption of AC electric power.

In the United States and other countries, EMF health effects concerns have triggered public, regulatory, and judicial involvement—

Induced AC electric current in a person standing in a 1 kV/m vertical 60Hz electric field.



not to mention media interest—in numerous transmission facility construction projects over the past 15 years. Two examples illustrate:

The *Houston Lighting & Power Company vs. Klein Independent School District* case in Texas has brought schools into the issue. In November 1985, a civil court jury voted 5-to-1 to assess HL&P \$25 million in punitive damages for routing a 345kV transmission line near

Houston suburban schools. The rationale was "reckless disregard of (HL&P's) discretion," because the utility was aware of reports suggesting the possibility of childhood cancer from residential exposures to 60Hz magnetic fields when it routed the line in 1981. During the past year, the case has been repeatedly cited as justification for not routing transmission lines near schools or buying school property near existing easements. The line has now been rerouted.

In 1987, the New York State report drew considerable media attention. One of the Project's 16 research studies was an epidemiologic investigation of the purported association between residential AC magnetic fields and childhood cancer in Denver. The study found weak-to-moderate risks for homes with elevated magnetic field levels, using surrogate exposure measures, such as power line wiring configurations. In assessing this research, the report extrapolated the results, stating: "The incidence rate of childhood cancer is approximately 1/10,000/person-year. If the association with magnetic fields... is causal with a relative risk of about 2, ... the incidence rate would be increased to 2/10,000/person-year. ... With the wire code distribution (seen), ... and the assumption of a causal effect, this would mean that 10-15 percent of all childhood cancer cases are attributable to magnetic fields."

Unfortunately, out of the entire report, this one statement captured most media attention. During late 1987, major articles appeared in leading newspapers and magazines around the country. Bioelectromagnetic scientists have been repeatedly interviewed on radio, on the *Today* show, and on *ABC World News Tonight*. In reporting the 10-15 percent childhood cancer increment, the media lost sight of the important caveats on this figure and also continued to implicate high-voltage transmission lines, not the routine residential exposures studied.

Together, both *HL&P vs. Klein* and the New York State report have indelibly linked power lines in the public mind with children, cancer, and schools.

What can we conclude about health?

Most evidence implicating AC magnetic

fields comes from epidemiologic research, with suggestions of excess cancer risks among "electrical occupations" and among children exposed to higher background 60Hz magnetic fields in their homes. Relative risk estimates are typically in the 1.5-3.0 range, a moderate risk. It seems to me that the general pattern among more recent studies incorporating improved exposure assessment and methodological techniques, including the Denver study, have reported either no risk or even lower relative risks, around 1.5-1.9, for the more reliable estimates (editor's note: see Commentary).

Despite these difficulties, this research can't be dismissed: the studies are consistent enough to warrant more investigation. But if AC magnetic fields are cancer promoters, they appear a weak risk factor at most. Unequivocal confirmation will have to come from the laboratory.

In the meantime, we can expect continued opposition to new transmission facilities and to siting schools near easements; reluctance to buy homes along power line corridors; increased labor concern; possibly, a wave of

personal damages litigation; and continued news interest.

New York State's recommendation for research into engineering controls to reduce background residential magnetic fields must be approached cautiously. Electric power distribution represents billions of dollars in equipment, designed in part to ensure safety. We may face difficult tradeoffs between costs for controls, possible compromises in electrical safety, and lowering possible childhood cancer risk.

Thus, many would argue that we should delay implementing controls, unless they are trivial, until researchers can establish causation and regulators can determine the public's willingness to bear the cost of abating the risk. As the August 1987 *Child Health Alert* observed, "Even though childhood cancer is frightening and the issue of power lines is emotionally charged, we should keep in mind that doubling the risk of a very rare event still leaves us with a very rare event," a view some epidemiologists share.

Some suggested readings on EMF: Kuhn and Banks, "Emerging issues in extremely-low-frequency electric and magnetic field health research," Env. Research 39:386-414:1986; Abitham et al. Biological Effects of Power Line Fields. New York State Power Lines Project. Scientific Advisory Panel Final Report. Albany. New York: New York State Power Lines Project: 1987; Transmission/Distribution HEALTH & SAFETY REPORT. P.O. Box 14501, University Station, Minneapolis, Minnesota 55414; Microwave News. P.O. Box 1779, Grand Central Station, New York, New York 10163.

Commentary

Electromagnetic Fields: Do We Know Enough To Act?



by David O. Carpenter, M.D.
Dean, School of Public Health,
SUNY/Albany, &
New York State Health Dept.

Robert Banks' article is thoughtful, and I differ with him only in interpretation of some of the available information and in degree of urgency in doing something about the problem.

A major strength of the New York State report, *Biological Effects of Power Line Fields*, is that its nine-member review panel was assembled with particular attention to members having both no preconceived view on the question of hazards and no con-

lict of interest that might cloud their interpretation of data. Further, this group is the only recent review committee that had the opportunity to test hypotheses in a research program before making recommendations and drawing conclusions. In the unanimous view of these nine people, the evidence to date, while not constituting proof of hazard, is sufficiently compelling to necessitate immediate action, both in engineering and biological research. The evidence for serious effects of magnetic fields gets stronger each year.

Health effects of concern

The New York studies identified

two areas of particular concern: cancer and nervous system effects. Man and lower animals have exquisitely sensitive neural detectors for electric and magnetic fields and use these fields for locomotion and migration. Only recently has it become clear that man also has magnetic field detectors, linked to the parts of the brain that control body rhythms. At least some of the effects of magnetic fields on rodent and monkey behavior found in our studies are probably mediated through these pathways. Other effects of fields, such as changes in susceptibility to epileptic seizure induced damage, changes in the chemical constituents of spinal fluid, and

changes in learning ability of rodents exposed to fields just before and after remain to be explained. These studies clearly indicate that fields may adversely influence behavior and neural functioning.

In light of the New York State Power Lines Project's epidemiologic study of residential magnetic fields and childhood cancer, I strongly disagree with Banks' conclusion that "recent studies incorporating improved exposure assessment and methodological techniques have reported either *no risk* or even lower risk estimates." In my view and that of the New York State panel, the evidence for a correlation between residential magnetic fields and childhood cancer is too strong to be passed off. I agree that society faces difficult tradeoffs between costs and inconvenience of changing our system of distribution of electricity and our ability to reduce cancer incidence, especially in children.

What's the public health risk?

Is the problem trivial from the public health point of view? It is true that childhood cancer is relatively rare (occurring at a rate of about 1/10,000 per year). There are 72,000,000 children in the US—about 7,200 cases of cancer each year. Thus, if 10-15 percent of childhood cancer is due to exposure to magnetic fields from the distribution line in the street, this translates to cancer in about 1,000 children in the US. The estimate of 10-15 percent, however, is restricted to cancers due to the distribution system at the residence, and does not consider exposure from appliances and other sources. Thus the magnitude of contribution of magnetic fields to childhood cancer could be greater than 10-15 percent. My guess, assuming a linear dose-response relationship, is that the contribution could be greater by a factor of two. I base this

on the observation that fields measured in the centers of rooms in the New York State studies were 30 percent greater when lights and appliances were on. Occupants' exposure, however, is likely to be greater because of time spent close to appliances.

The occupational literature, though incomplete, suggests that leukemia, lymphoma, and brain tumor rates are higher in people employed in "electric" occupations. These diseases are also relatively rare even in adults (incidence rates of about 1/10,000 each for leukemia and lymphoma, and about 1/50,000 for brain tumors). Since there are 168,000,000 adults, about 42,000 adults develop these cancers each year. If 10 percent of these adult cancers are related to magnetic field exposure, and if no other cancers are correlated with exposure (neither assumption well supported by hard data), the total "body count" is on the order of 2000 cases of childhood cancer and 4000 cases of adult cancer per year.

Compared to some other causes of death, these numbers are relatively small. But, if these deaths can be prevented by changes in the way power is distributed and used, changes we do not yet know to be complex or expensive, then it is unethical not to proceed immediately to determine how power can be distributed and

used with reduced magnetic field exposure to humans.

The lack of a good animal model and clear understanding of a mechanism whereby magnetic fields cause cancer are factors that lessen enthusiasm for drastic action. However, there has been relatively little effort in either area. To my knowledge there has never been a study of exposure of animals to 60Hz fields that looked for cancer as an endpoint. Such a study should be a national priority. Use of a leukemia-prone strain of rodents would be a good place to start. In the New York State Project, the only studies geared at possible mechanisms of field-induced carcinogenesis focused on genetic effects, and these were negative. While recent studies by Adey et al. (*Carcinogenesis* 8:1385, 1987) on possible cancer promotion by fields open several new areas of research, clearly, much more work is necessary.

While societal unrest over questions related to magnetic field effects is a major inconvenience, especially in the form of litigation based on inaccurate information, there is reason for citizens to be concerned. I do not want my child exposed to an increased risk at home or at school, even if it is small, if that risk can be avoided. The challenge now is to define the risk better and find and implement ways to avoid it.

Readers' Forum

Readers' Forum publishes questions, comments, methodological discussions, and short case histories. David Parker, M.D., M.P.H., of the Minnesota Dept. of Health coordinates questions and answers. Send letters to: Health & Environment Digest, 5901 Brooklyn Blvd., Suite 109, Mpls, MN 55429.

Dioxins Redux

The principal sources of dioxins in the

environment are wood burning fireplaces, wood burning stoves, and forest fires. Chemical by-product dioxins do not comprise even 0.01 of 1 percent of what Mother Nature's raw materials are capable of.

—George Andrae, P.E.

DuPage County Health Dept.
Wheaton, Illinois

Though dioxins may form in fireplaces, they are more likely to form from the combustion of manmade chlorinated compounds. In technologically developed

Continued on p. 8.

Common problems often cause stray voltage

By ROBERT KEYES
Staff Writer

Stray voltage is not necessarily less common today than in the past, but it's probably a less shocking occurrence now that farmers are more aware of its existence.

The phenomenon, which was first noticed about 10 years ago, occurs on farms nationwide, and dairy farmers in particular have felt the effects of what is technically known as a neutral-to-earth voltage problem.

Dr. Harold Cloud from the University of Minnesota is credited with discovering stray voltage after a southern Minnesota farmer complained he was having some unusual problems with his dairy herd about 10 years ago, according to Floyd Fischer, information director at Lake Region Co-op Electrical Association in Pelican Rapids.

As has been typical in stray voltage reportings since that time, the farmer complained that his dairy cattle were nervous and jumpy, they wouldn't eat or drink and, in general, they just acted unusual.

As a result of stray voltage, milk production has been shown to decrease, although it is not known exactly how much. And although the problem affects dairy farmers more severely than other farmers, all types of agriculture operations have experienced stray voltage.

Thus, a full-scale investigation of the problem

began locally in the early 1980s, which has included input from the co-op, Otter Tail Power Co., the U of M and North and South Dakota State Universities.

"We found that it had a broad range of causes, some real complicated and some as simple as poor wiring," said Jerry Martens, an Otter Tail Power stray voltage specialist.

Martens, who has been studying stray voltage full time since about 1985, said that although much has been learned about the problem, it is not under control.

"Stray voltages are typically smaller voltages (from one-half to about two volts). We try to get them down to a under .35 volts throughout the farm system," he said.

In combatting the problem, Martens and Fisher agree that the most common causes of stray voltage are poor wiring, improper grounding, electrically faulty motors or an imbalanced electrical load somewhere in the system.

It has also been suggested that the company's powerlines may contribute to the problem somehow, but Martens asserted that is more the exception than the rule.

"It's the common things, wiring, etc. (that are usually responsible)" he said.

Otter Tail Power and the co-op both offer free stray voltage analysis to their customers, and Martens said that, since it's the type of problem that often reoccurs, it requires constant monitoring.

"Dairy farm operations are the most common (farm setting) for stray voltage to occur because there are so many electrical things going on," he said. "I think there are a lot of farmers out there who are very aware of the problem, but they don't know how to remedy it."

So with the help of some elaborate electronic testing equipment such as a "Wave Rider," a "Chessel" and a "Ram-Corder," Otter Tail Power conducts its tests at the dairy farms during milking times — early in the morning and early at night, according to Martens.

"We also send a mailer out to each of our rural customers looking for cases of stray voltage," he added.

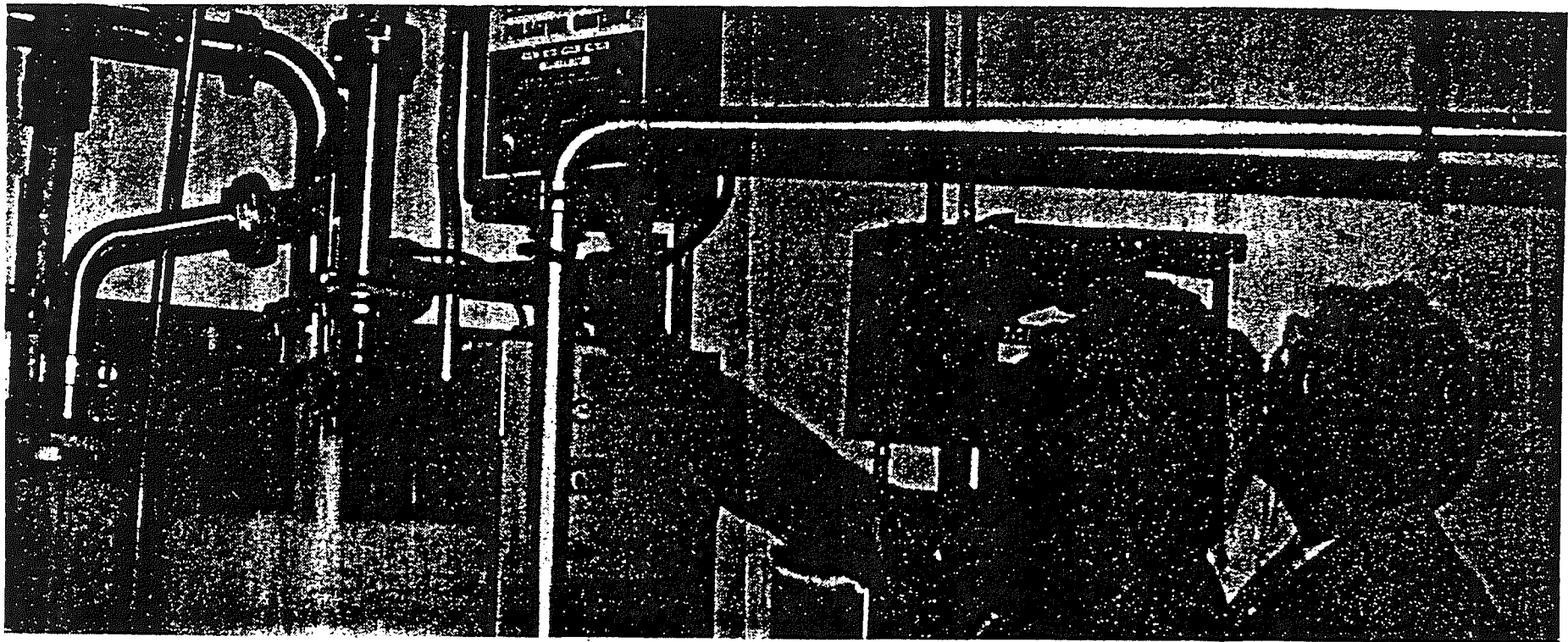
The findings have been startling.

"I'd say that in some way or another, (stray voltage) affects every dairy farmer in Otter Tail County," Martens said. "Almost without exception, we've found problems, even with the best producers. If we thought for one minute that we were getting a handle on it, we'd be fooling ourselves. We still have to keep monitoring it constantly."

But, he added, "I think we've come a long way in dealing with the problem. There's a real sense of unity in working together (with the co-op, the universities and farmers) on this."

"That's good because we have a long way to go."

4 Thursday, June 9, 1988



Otter Tail Power stray voltage specialists Jerry Martens, left, and Keith Folger inspect the wiring in a pulsator box that was found to be a source of stray voltage.



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Stray voltage grounds dairy

By TIM McALAVY
Country World Staff
NEAR THE RED RIVER

— 'There's voltage somehow gettin' to these cows,' is a statement that no dairyman wants to hear. 'Juice,' or stray voltage, can be an elusive, frustrating problem that can cause drawn quarters, hard udders, lower milk production, low conception rates, and nervous (or even broke-down) cows.

This is the story of how one producer battled a stray voltage problem. For the purposes of this article, he will be referred to as producer Y.

In May, 1987, Y began a 100-cow Holstein operation near the Red River on leased property; 280 acres, a double-four herringbone parlor and barn, and a home. With years of cattle experience (beef, forages, dairying), Y figured a top-notch dairy would be the key to realizing his dream of a dual purpose dairy and beef operation.

It took him more than a year to get financing through a government lending agency, but he prevailed and, with the help of two cattle buyers, purchased high-bred cattle to begin the operation.

Y joined a large dairy cooperative, and contracted

with them to completely remodel the parlor from a double-four to a double-five; with a new feeding system and low pipeline.

"Our problems started in early July that year," Y said. "We had a sudden outbreak of mastitis, but I didn't find this real unusual. We doctored for it, but had to dump most of the milk. Then I started getting alarmed at some of the best cows developing hard udders, and when even the gentlest cows started going haywire in the parlor...kicking to kill...I knew we had a real problem."

Milk production dropped dramatically. The cows were not milking out, and milkers wouldn't stay on the cows. Y suspected an equipment problem, and called on his cooperative's field service department. They came out and performed a system analysis check, and found no equipment problem. Y was puzzled.

A month later Y was still doctoring mastitis and was behind on the bills...no salable milk, no creditor payments. The herd's health worsened. Aside from their nervous behavior in the parlor, the cows developed runny eyes and drawn quarters. Y observed them standing 'buckled up' and quivering after leaving the parlor. By now some of the cows were so nervous they had to be driven into the parlor five at a time.

Y called on his veterinarian for help. The vet had been performing regular herd health checks every 40 days and helping him treat the mastitis. "He was the first one that suggested stray voltage," Y said. "Up until then, I'd never heard of such a thing. But I sure learned in a hurry. I had to. I was going crazy. Everything was set up for a quality milk operation...from the cows' breeding to the feed ration to the parlor...and we were still dumping milk, not able to pay the bills."

Y did a lot of research; running up a huge phone bill talking to anyone who could give him information. He contacted his rural electric cooperative to come out and check the barn with a voltmeter.

"They checked the transformer where their power was coming into the barn and found nothing unusual," Y said. "I also contacted a local master electrician, and he came out

and ran a voltmeter and megahertz test on the barn. We found 20 volts of stray voltage getting to the cows through the feeders."

The feeders were grounded, and things returned to normal...for a while. Meanwhile, the mastitis subsided, but Y faced a backlog of unpaid bills. "I was lucky to have creditors that believed in me," he said. "They knew I was having problems, had a good operation, and agreed to carry me. We switched to a different feed company to improve the ration, and milk production went back up...somewhere around 70 pounds a day on our first-calf heifers. At this time (October) we had 75 cows milking and 15 dry."

Hard rains in November signaled the return of Y's stray voltage problems. Mastitis came back in a big way, he found more hard udders on cattle, and most cows were not milking out. The nervous behavior also returned; kicking and refusing to enter the parlor.

"I called my milk cooperative and told them I had a problem with stray voltage," Y said. "This was after three equipment checks by their field men. They told me if it was stray voltage, there was nothing they could do to help."

In early December, with his milk hand on vacation, Y was milking alone. Stressed to the breaking point, Y was driving the cows into the parlor, milking, doctoring, and frazzled from dealing with 'kicker' cows. "I was going nuts. I was sick, alone, and nothing was going right despite my best efforts," he said. "We were dumping milk again, the bills were piling up, my lender was threatening foreclosure, and it was taking me four to five hours to milk 65-70 cows. I had 15 head dry, and about that many so broke down they were in the cull pen."

"I finally lost it completely, broke down and started crying...I prayed in the parlor on my knees for the Lord to help me, and gained

some reserve strength from that release," Y said.

The next day, Y called the milk cooperative for help, but was again told, 'if it's stray voltage, there's nothing we can do to help you.'

He called the electric cooperative, and a crew came

— Voltage —

Continued on page 3



★ Stray voltage

— Voltage —

Continued from page 1
out and installed an 'isolator' (price tag \$600) at the transformer pole to keep any electricity from bleeding back off their line into the barn. He also called the local electrician back to help. Even with the isolator installed and the feeders grounded, the electrician found 1.7 volts getting to the cows at milking time.

After milking, Y and the electrician started checking all electric motors in the barn and correcting grounds. They eventually found the source of the 1.7 volts of stray 'juice': eight improperly grounded feeder timer motors. "We determined they were leaking electricity through the insulation," Y said. "He replaced those motors with new ones that are better insulated and grounded, and our problem in the barn stopped."

In the case of Y, the prob-

lems and complexities caused by stray voltage have been disastrous. He has been saddled with ruinous financial problems and a drastically crippled cow herd.

To date Y has lost 30 otherwise good cows to mastitis and staph infections induced by the stray voltage. At least ten others in the herd have at least one ruined quarter or hard udders, and all are still skittish when in the barn.

But Y is optimistic.

"I've never been a quitter, and I never will be," he said. "It took more than eight months to find and correct a problem that I'd never even heard of, or dealt with, before. The bills are still there, but we're not dumping milk anymore. I'm selling every calf I get to pay the bills, but we're not giving up. Sooner or later we'll work our way out of this into that light at the end of the tunnel."

CA EMF Health Effects Bill Signed into Law

On September 29, California Governor George Deukmejian signed into law a bill requiring state utilities to fund a two-year, \$2 million research project on the effects of electromagnetic fields. These funds are in addition to \$100,000 already allocated in the governor's current budget (see MWN, M/J88).

The initiative, prompted by the results of the New York Power Lines Project, will allow for an independent evaluation of health risks. All electrical utilities with revenues over \$25 million will help finance the research.

The new law, chapter 1551, which was proposed by Senator Herschel Rosenthal, calls for the Public Utilities Commission and the Department of Health Services to run the project as a joint effort. The agencies must submit a status report by December 1, 1990.

Copies of the law are available from: Senate Energy Committee, Room 2035, State Capitol, Sacramento, CA 95814, (916) 445-9764.

STRAY VOLTAGE STUDY

The latest information on this hard-to-solve dilemma may surprise you.

Stray voltage has drawn a lot of attention in the past few years. It is a phenomenon that results in a small electric potential being present between grounded equipment and earth. When an animal bridges this gap, the resulting current has been thought to adversely affect the animal, particularly in the dairy operation.

The findings of recent studies, however, surprised researchers and may surprise you. These studies indicate stray voltage doesn't directly decrease milk production. But the way a dairyman manages the problem can cause a decline.

Research so far hasn't shown any significant physiological changes in animals affected by stray voltage, says Dr. Robert Appleman, University of Minnesota extension dairyman. I would conclude that the primary cause of mastitis or low milking performance on so many farms is the result of the

operator's milking routine being disturbed or upset because of the animal's change in behavior," he says.

His example of milking time per cow illustrates this point. In a typical double - 4 herringbone parlor, time required to milk 4 cows equal 6 minutes, or 1.5 minutes of chore time per cow. That means 40 cows are milked per hour. If you assume behavior changes because of stray voltage, tack on 2 minutes to the routine. Now it takes an hour to milk 30 cows.

"This is a 33% increase in milking time!" Appleman says. It tempts producers to take short cuts and causes incomplete or uneven milking, leading to increased mastitis and somatic cell count. Blame for these and other symptoms is pinned on

"Nine Farm" Study on Stray Voltage and Dairy Cows

In Wisconsin, dairy production losses have prompted a new look at stray voltage on the farm. A recent "nine farm" study prepared by the Stray Voltage Analysis Team (SVAT)—a state-appointed voluntary group of farmers, utility representatives and veterinarians—recommends that farmers experiencing milk production problems consult with utilities to find workable solutions. (Livestock ailments are also associated with stray voltage.)

Among the SVAT's recommendations are that utilities improve existing primary electrical systems by adding grounding rods to the neutral conductors and that power line wiring

be aboveground for easy inspection. For farmers, the SVAT advises periodic assessments of their electrical systems and regular communication with utility representatives.

Although the SVAT describes the volunteer effort as "successful" on an individual farm basis, it calls for future studies to be more formally organized and coordinated.

The report was submitted to the Stray Voltage Task Force of the Wisconsin Department of Agriculture, Trade & Consumer Protection and to the Wisconsin Public Service Commission. The task force was set up in January 1987.

For more information, contact: Bob Ehart, Executive Assistant, Wisconsin Department of Agriculture, Trade & Consumer Protection, 801 West Badger Road, PO Box 8911, Madison, WI 53708, (608) 267-9423. The report was initially released in November 1987 and was reprinted in the spring.

Rural MD News
October, 1988

stray voltage on reportedly 20-30% of dairies nationwide. Appleman works intensively with the problem. He made 200 related farm visits in several states between the years 1978 and 1985. Three universities have researched this problem since 1983.

Appleman's research concludes that some cows can detect currents of 1.0 mA, but it requires 3.0 mA to alter milking routines. In some cases in the field, cow's behavior changes when the voltage is increased to 1 volt. "Anything below .7 volts is okay. The goal is to have even less voltage than that," he says.

Research done elsewhere reinforces Minnesota's results. Dr. Alan Lefcourt, a USDA biomedical engineer at the Animal Research Center, Beltsville, MD, did four studies

subjecting 23 cows to electrical shocks during milking for one week. He found that shocking had only minimal effects on milk production and udder health. He also found shocks caused severe changes in cow's behavior. How much this behavior decreases milk production depends on how dairymen deal with the problem. According to Lefcourt, electrical shock is a secondary problem and can be lessened by changing management practices.

Minnesota's Appleman says the problem hasn't changed. Stray voltage still exists and you still have to do something about it. Dr. Lefcourt adds, "A farmer can't just look at his cow's behavior and tell it's a stray voltage." Many of the symptoms often associated with stray voltage could also be attributed to mistreatment, milking machine problems, disease, sanitation, nutritional disorders, environmental or housing changes.

Concern About Low-Energy Radiation Leads to New Rules, Research and Suits

10-11-88

By BILL PAUL

Staff Reporter of THE WALL STREET JOURNAL

NEW YORK—Growing public concern about the cancer-causing potential of low-energy radiation from power lines, broadcast towers, ham radios and other supposedly harmless electronic gear is creating problems for electric utilities, municipal officials and others.

Power-line construction, for example, has ground to a virtual halt because of people's fear that extremely low (60 hertz) electromagnetic fields generated by overhead power lines can cause cancer and learning disabilities.

In Fremont, Calif., the planning commission is requiring the state real estate department to warn potential buyers of homes in a new subdivision near power lines that the lines may pose a health risk. Other cities, including Portland, Ore., and Seattle, have passed or are considering putting tough new exposure limits on radio-frequency and microwave radiation from broadcast towers. And a growing number of workers are suing their employers, claiming to have developed cancer from exposure to electronic equipment that emitted low-energy radiation.

Fueling the concern is a host of recent studies—which add to an already significant body of research—that suggest, but by no means prove, that low-energy radiation may be linked to cancer, learning disabilities and gynecological problems in as-yet-unexplained ways.

Only Statistical Correlation

All of the studies, which are preliminary, offer only statistical correlation between radiation and the problems cited. None purports to identify the mechanism by which the problems might be caused. Moreover, most have been attacked as flawed by groups representing such suspect items as video display terminals; power lines and ham radios. A recent editorial in the American Journal of Industrial Medicine concurred that at least some studies had methodological flaws.

But the same editorial said there are now so many troubling studies that electromagnetic energy "must be considered an environmental health hazard and dealt with accordingly, until proven otherwise."

Louis Slesin, publisher of Microwave News, a New York-based newsletter on radiation and its health effects, says the studies show that "there's a real possibility we may have a big health problem on our hands."

The federal Environmental Protection Agency is also concerned. Last May, EPA Administrator Lee Thomas announced that the EPA would help try to determine whether children with cancer in McFarland, Calif., got the disease from radiation emitted by a nearby radio-broadcast tower. "I share the public's concern about the suggested link between electromagnetic fields and human cancer," Mr. Thomas said at the time. EPA testing in McFarland is expected to begin later this year, an agency spokeswoman now says.

Other electronic equipment causing concern, according to Mr. Slesin and others,

includes such consumer items as cellular telephones and electric blankets.

It's long been known that high-energy or ionizing radiation, such as X-rays, is dangerous because it can disrupt human molecules. But low-energy or non-ionizing radiation—ranging from the extremely low fields put out by power lines, to the somewhat higher fields generated by VDTs, to the radio-frequency fields generated by ham radios and transmission towers—had generally been considered safe because it can't break molecular bonds.

A couple of studies have already made headlines, in particular, one last June by the Kaiser Permanente Medical Care Program in California. It found that pregnant women who work in front of VDTs more than 20 hours a week have twice as much chance of miscarrying as other clerical workers.

But most haven't yet attracted attention, including one published last June in the American Journal of Industrial Medicine that found that utility workers exposed to electromagnetic fields are 13 times more likely to develop brain tumors than unexposed workers. The study was based on randomly selected mortality data for men in east Texas.

Meanwhile, a recent study by the Washington state Department of Social and Health Services found that amateur radio operators have a higher-than-normal cancer death rate. The Hawaii Department of Health found that people living near radio and TV broadcast towers had a significantly higher incidence of cancer.

And, in a soon-to-be published study, the former president of the New York Academy of Sciences, Kurt Salzinger, found that rats exposed in utero to extremely low frequency radiation later showed signs of learning disabilities. Mr. Salzinger, a psychology professor at Polytechnic University in New York, exposed one group of rats to the same frequency as emitted by power lines (60 hertz). Then he trained that group, and a control group, to press a bar on command. He found that the group that had been exposed to the radiation was significantly slower to respond on command—a problem, he says, that didn't go away as the rats got older.

Corning Glass Works

Corning Glass Works said it formed a previously announced venture to make color-television tube glass with Asahi Glass Co. of Japan. Terms weren't disclosed.

The new firm, Corning Asahi Video Products Co., will make the tube glass at Corning's plants in State College, Pa., and Monterrey, Mexico. Corning's 67% stake in the venture will eventually drop to 51%, as Asahi increases its ownership to 49%. Asahi, a glass and chemical maker, will provide a technology license for the new company.

John W. Loose, a Corning Glass vice president, has been named chief executive officer of the new company.

Corning is a telecommunications, specialty glass, ceramic products and laboratory services concern in Corning, N.Y.

Orland Hills, Ill.—Because no one has been able to explain the mysterious fires, account for the sulfurous odors or rationalize the eye-burning white haze, what some call the Chicago area's own version of the Amityville Horror has been bulldozed into rubble.

"All of this talk about a haunted house is ridiculous," a distraught Karen Gallo said Friday as she watched workers fill the hole in Orland Hills where an attractive bilevel house had stood only 24 hours before.

"This has taken a tremendous emotional toll on my family. And all I know is that I've lost my home for a reason no one can explain. I don't know if we'll ever find an answer."

Reason or no reason, Travelers Insurance Co. agreed it would pay off on the property if the house was torn down, which it was Thursday. It had been vacant since April 12, when Bob and Karen Gallo, who bought the house in 1981, moved out with their 14-year-old daughter and 7-year-old son, on the advice of local police and fire officials, a few days after the third fire in a month.

The case has baffled arson investigators Terry Hyland and

Steve Smith of the Orland Fire Protection District, who say they ruled out "everything" over the last 7½ months, including arson, pranks, natural gas, methane gas, sewer gas and a faulty electrical system.

"There is no logical explanation," Hyland said. "Thank God this is the end of it."

Not everyone agrees. "We really don't think there was any mystery," said Joe Skubisz, associate manager of Travelers Insurance Company's claims office in Naperville. "It was probably a gas leak."

Once, a blue flame an inch in diameter shot out of a wall socket for more than 30 seconds, and the outlet still worked. That incident was witnessed by two police officers. Another time, a

similar fire set a mattress afire when investigators were outside.

In all, there were 26 separate incidents, 11 of them witnessed by either police or fire investigators, Smith said.

"I was there one night when the room filled with a white haze. I couldn't see my hand in front of my face," Smith said. "There was a strong sulfur smell and my eyes were burning. I took a sample (of the vapor) in a vacuum canister. We came up with nothing."

Neither did engineers, chemists and geologists.

Packer Engineering Inc. in Naperville, hired by the insurance company to investigate, struck out when it took infrared photographs to see if there were

any heat differentials in the house.

Smith and Hyland used a fog machine to try to trace air currents between floors, but they found none. After spending considerable time in the house — sometimes spending the night — they had their own blood analyzed to see if anything was there that shouldn't have been. Nothing was.

Karen Gallo said she was extremely upset with the notoriety the house had received and wouldn't even consider the possibility of a paranormal explanation. "There were never any garbage cans flying around or anything like that," she said.

SVAT team looks for tiny clues

Group seeks answers to stray voltage

By REGGIE McLEOD
Agri News Special

INDEPENDENCE, Wis. — When the three-man team of investigators arrived at the dairy barn, sunrise was an hour away and the mercury dozed near zero. Launching their first investigation as a team, the men searched for clues, asked questions and studied monitoring devices.

The newly formed Stray Voltage Analysis Team was mandated by the Wisconsin Legislature to do the detective work on especially tough cases in which low voltage electricity is suspected of shocking cows. These cases can be tough to solve because the problem may be caused by anything from a loose wire or bad motor, to the wiring on the power line or on the farm down the road. Making matters worse, it may only occur when the wind blows a certain direction or when a neighbor switches on a machine.

If the team does its sleuthing well, it will be disbanded in 2 1/2 years, and the Wisconsin dairy industry will be healthier for its efforts.

In the milk house, Mark Cook, an electrician from Stoughton, flipped switches on a handmade measuring device connected to a tangle of wires leading off into different sections of the barn.

"We've got this box designed so we can check 12 different locations without changing the probes," he explained.

Where stray voltage is a problem, cows are shocked when they form a bridge for electricity to flow between two points, such as between a metal drinking cup and the floor. The box can simulate a cow's resistance to electricity, allowing Cook to search for situa-



Agri News Photo by Reggie McLeod

JEROME KREIBICH WATCHES as his DC volt meter registers .509 volts between the barn's water pipe and gutter. He asked the Wisconsin Stray Voltage Analysis

Team to look for a stray voltage problem in his dairy barn. The team handles tough stray voltage cases for Wisconsin farmers.

tions in which a cow would get a jolt strong enough to feel.

Stray voltage makes cows nervous and stressful. Many of the symptoms they suffer are a result of the stress. They may not eat or drink enough, suffer from poor digestion, become hard to handle, afraid to enter or leave the barn or suffer from other health problems. When the problem is fixed it may take as little as 30 days or as long as two years for the herd to recover completely.

"I've had problems with the herd for quite a few years," said Jerome Kreibich, who asked the SVAT team to visit his farm. "The cows are uneasy, and a lot of them have mastitis trouble (udder inflammation).

"I've seen times the cows don't

want to come into the barn and times they don't want to go out of the barn. It's a mystery."

He pointed to a voltage meter hanging on a nail next to a milking stanchion. It was reading .509 volts of direct current between the water pipe that supplies the cows and the gutter that runs behind the cows.

"Yesterday it got up to around six volts," said Kreibich.

The reading usually peaks at chore time — from about 5:30 to 7:30 in the mornings and evenings. It tends to read higher when the temperature is changing, he said.

Cook said the team does not have the authority to check DC direct current; it is only sup-

posed to check for stray AC (alternating current). The Department of Agriculture, Trade and Consumer Protection and the Public Service Commission have determined the lowest level of current that will affect cows is 1 milliamper. Depending on what path the current travels through the cow, it would take between about 0.35 and 0.5 volts of alternating current to cause a problem. Other livestock, notably hogs, are probably also affected by stray voltage, but the Wisconsin program will focus on cows.

One milliamper is a very conservative standard. Research at Cornell University set the low threshold two or three times higher, according to Cook.

Sec SVAT Page 9

★ SVAT: It takes hard work to find problems

Continued from Page 7

"It takes twice as much DC to have the same affect on an animal as AC," he said.

By 10 a.m. Cook had taken more than 250 readings and found none above 0.3 volts AC.

The team will normally spend several days on a farm, taking electrical readings, inspecting equipment and studying farm records.

"Farmers will get a darned good evaluation of the entire operation," said Tom Beane, a farmer from Fort Atkinson and the team's farm management consultant.

On this particular day the team scheduled meetings with the county extension agent, feed salesman

and workers from the electric utility.

Past research has traced problems to mercury vapor yard lights, a machine in a nearby quarry and weather.

"The best thing you can do is keep a daily log," said Beane. "Once you start creating a pattern, it's pretty easy to guess what's happening."

Some farmers have learned to work around stray voltage to get better-than average milk yields without fixing the problem. Cows may learn to avoid parts of the barn, or the farmer learns the herd is easier to milk at a different time, or culling low yielding cows leads to a herd genetically more tolerant to shocks, or the farmer may learn to turn off a certain piece of electrical equipment

when cows are entering or leaving the barn.

Both Beane and Cook served as volunteers on the Stray Voltage Task Force, which studied nine farms for six months to establish that the problem of stray voltage actually exists. They only collected data and did not make recommendations.

After they submitted their report the Department of Agriculture, Trade and Consumer Protection and the Public Service Commission held hearings and collected research data to set standards and devise a plan.

The state legislature has funded the team through June 1991. Until then, the group will spend several days on each farm, working with about one farm per week.

"I kind of look at this as a three part job: One part is education, one part is to gather data; and the rest is going out and helping people," said Beane. "Give us two or three years, and I think we'll have a good handle on the problem."

The team members said they know of no similar programs in other states.

The solution probably involves getting farmers to do the same sort of maintenance and monitoring farm electrical systems that they already do on their tractor, milking equipment and livestock. Even after a problem is solved, monitoring and maintenance must continue, to ensure it does not return, said Cook.

Reggie McLeod is a freelance writer headquartered in Winona, Minn.

Hunting down electric pollution

By CYNTHIA ORANGE
Special Correspondent

About five years ago, dairy farmers started coming to Dr. Duane Dahlberg, former chair of the Minnesota Pollution Control Agency, current professor of physics at Concordia College in Moorhead, and Frazee resident, with some very strange stories.

"Our milk production went down 4,000 pounds and we were always treating one or more cows for mastitis," reported Marcene Hagen of Underwood. Sue Shol of Erhard described how her stomach and that of her 11-year-old daughter would swell when they enter their barn.

"Our stomachs rise to the point of looking eight months pregnant. If we leave the barn

Frazee scientist searches for solutions

and sit in the car, they return to normal size."

Shol also noted that when their cows exhibited signs of distress and milking problems, her family's abdominal problems and other physical ailments (aching legs, nausea, mood swings, sore eyes and tingling feet) got worse.

One farmer, David Lusty of Millona, has been foreclosed on once and had to file bankruptcy because of similar problems. "We had slow, uneven and incomplete milkouts; cows kicking during milking; cows with sore

teat ends, swollen legs and joints, retained placentas and both short and long-term abortions. There was a significant increase in mastitis and other diseases, even though we were participating in a good vaccination program."

Eugene Illies recounted some things that were happening in his little town of Elrosa. "We have experienced a considerable number of headaches, muscle aches, dizziness, eye trouble. In fact, some have lost eyes. In this small town of 200 people, I know of 11 people that have had to visit

counselors regularly due to depression and hyperactive conditions. Suicide problems have really increased since 1978" (When a high voltage power line was erected.)

These people like the many others who have contacted Dr. Dahlberg, had a hunch that the troubles they were having had something to do with electricity, but they could not find anyone who cared enough to listen or give credence to their theories—that is until they met Dr. Dahlberg. Maybe it's because he grew up on a family farm or

maybe it's because he's an ordained Lutheran minister. Whatever the reason, Dr. Dahlberg has become a kind of "electromagnetic ghostbuster" among rural folk. When he began his investigation, however, he had no idea what a Pandora's box he would uncover.

Whenever electricity flows through a wire, a magnetic field is created. Your toaster, your electric blanket and your power lines all generate electromagnetic fields. More and more, scientific research suggests that exposure to electromagnetic fields—even at low levels—can adversely affect living organisms. Farmers generally call this phenomenon

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DETROIT LAKES TRIBUNE—THURSDAY, FEBRUARY 2, 1989

Electric

Continued from page 1A

stray voltage." Environmentalists often call it "electric pollution" or "electric tug." Scientists call it "ionizing radiation." Whatever it's called, it is all around us.

It's what makes our televisions, radios and lights work. Microwave ovens heat food with electromagnetic waves in order to cook evenly and quickly. The United States is wired with half a billion miles of high-voltage power lines. The average American gets a daily dose of electromagnetic radiation up to 10 million times greater than our prehistoric ancestors.

"Harmful effects are very rare," says Dr. Dahlberg. "The earth is a giant electromagnetic system, with its own natural electric and magnetic fields. The system is in a delicate equilibrium," explains Dahlberg.

But power lines and other electric transmitters create artificial electromagnetic forces that alter this natural magnetism. These fields enter our bodies and are now suspected of causing a myriad of ailments from stress-related diseases to cancer.

In addition to the problems reported to Dr. Dahlberg, other studies have indicated a strong causal relationship between electromagnetic radiation and health problems.

A Maryland study of 951 men who died of brain tumors between 1969 and 1982 revealed a high proportion of electricians, utility linemen and electronics technicians—jobs that involve exposure to electromagnetic fields.

Cancerous human cells died at the Cancer Therapy Research Foundation in San Antonio, Texas, were found to reproduce 24 times faster than normal when exposed to fields similar to those found near power lines.

In 1984, researchers noted an above-normal rate of

miscarriages among pregnant women who used electric blankets.

Studies have shown that heart rates and brain wave patterns can be altered by exposure to electromagnetic fields. Also, several studies have indicated that nonionizing radiation can alter the blood-brain barrier, a protective shield that excludes harmful substances from the brain.

At Sears, Roebuck and Company in Dallas, eight of 12 pregnant video display terminal (VDT) workers in the computer center experienced problems in one year (1979-1980), with seven miscarriages and one premature infant.

According to an article in the Chicago Tribune, researchers in a London hospital believe they have found patients who are allergic to electronic fields coming from such items as audio and video records, computer terminals, electronic watches and even household appliances.

People employed in professions which expose them to high electric and magnetic fields were found to have a higher rate of leukemia than normal. Also, Dr. David Savitz, an epidemiologist at the University of North Carolina, concluded, "Prolonged exposure to low-level magnetic fields may increase the risk of developing cancer in children."

Andrew Marino, a biophysicist at Louisiana State University, said he wouldn't live in a house near an overhead power line because, "The chances of getting sick are just too great."

Electromagnetic field problems are often more noticeable on dairy farms because of the economics involved. A farm family who relies upon income from milk production to survive is in serious jeopardy, if their cows aren't giving any milk. Dairy cattle are especially sensitive to the electromagnetic fields and a dairy farmer can lose as much as 20-30 percent of milk production because of problems associated with it, according to Dr. Dahlberg.

Many experts believe it is the combination of water and grounded electricity in barns that cause problems for



Dr. Duane Dahlberg

livestock, especially dairy cows. The cows' water cup, which is connected via pipes to a well, may be at a different electrical potential than the concrete floor of the barn. When the cow drinks from the cup, with its feet grounded on the concrete floor, a current can go through it, causing a shock or tingle charge. In efforts to correct this, some

farmers have tried to separate a power line's neutral wire from the neutral wire of farm equipment through the use of isolation transformers. In some instances, problems were relieved, at least temporarily. But in other cases, there was no improvement and the trouble seemed always present, whether or not the cattle were drinking. One farmer tried ungrounding some of his cows by elevating them on a trailer and noticed marked improvement. He also discovered that his calves, which developed diarrheawhen housed on the ground, became healthy when placed on the elevated trailer and grew faster.

Dr. Dahlberg says he has found that even minute amounts of current can affect people or animals. In one experiment, he said a fraction of a micro amp—about the power contained in a flashlight battery—caused a woman's arms to go numb after a few minutes of exposure. Dr. Dahlberg points out that it is difficult to assess the effects of the electromagnetic field on humans and animals because each being is different. Some individuals are far more sensitive to nonionizing radiation

and will exhibit more dramatic symptoms than will others.

Dr. Dahlberg also emphasizes that all confined livestock can be adversely affected by the electromagnetic field. Although most complaints come from dairy farmers, he has received reports of bee cattle, hogs and poultry all being affected, too.

In any event, that the electromagnetic field affects humans has been known as early as 1900 when D'Arsonval built one of the first 30-kilohertz radio-frequency power transmitters in France and used it to treat cancer victims. After World War II, the United States began a serious study on the biological effects of radar on soldiers.

Interestingly, the Soviet Union and other countries in the Eastern Block have devoted far more energy to studying the effects and potential dangers of electric pollution. In fact, they have had strict restrictions imposed for electromagnetic radiation exposure for many years. Their research has shown that electromagnetic fields may cause a plethora of health problems, including hypertension, heart attacks, headaches, sexual dysfunction,

drowsiness, nervous exhaustion and blood disorders.

In contrast, the Western World seems to be in a state of denial when it comes to studying the electromagnetic field and possible disorders stemming from exposure to it. Some researchers like Dr. Dahlberg, theorize that the United States government and American utilities have been reluctant to fund research because of the enormous threats the findings would pose. It has been the experience of many scientists attempting to study the problem that their research grants are not renewed and they are unable to secure any other financial assistance.

The Minnesota Legislature began funding research into the effects of stray voltage in 1985. Dr. Dahlberg indicated that so far the studies are confirming that the issue is far more complex and extensive than was first believed. He said that the results of the studies should be available within the near future.

STEVENS

(FLORIDA)
Palatka Daily News

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NYT

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Aug 2, 1989



**JACK
ANDERSON**

Stray volts big shock to milk cows

America's dairy cows are being shocked to death by electrical power surges in automatic milking machines. Thousands of cows have been slowly zapped to their eternal reward while farmers have tried in vain to get help from the federal government.

Stray voltage is to a dairy farmer what drought is to a grain farmer. But while dead corn and wheat can bring Congress or the Agriculture Department to the rescue, dead cows have been curiously ignored.

The excess voltage enters electric milking machinery that is hooked to the cows' udders. Though the charge isn't enough to kill the cow, she emerges from the experience a sadder but wiser bovine.

Once shocked, cows balk at the milking machines and even refuse to breed. Cows have been similarly shocked from the floors of their barns and from watering troughs. Farmers tell us that their cows drink the urine of other cows rather than venture near the water trough. The farmers say constant exposure to stray voltage weakens the cows' immune systems and they die of various diseases. During their slow death, the cows withhold their milk.

Dairy farmers must force their reluctant cows to be milked, at least until the cows die, so the farmers can stay in business. A few farmers blame stray voltage for putting them out of business. Some have successfully sued utility companies and the milk-machine installers for losses due to stray voltage. Many of the cases are quietly settled out of court and that keeps the controversy from gaining national attention.

But farmers now want their issue on the table. In Wisconsin, they have been fired up by a court decision awarding \$1.1 million to Wallace Daggett of Random Lakes, Wis. Daggett sued the Wisconsin Electric Power Co., claiming stray voltage had cost him 600 cows over a 10-year period. Daggett now gets calls every day from farmers who want to know what to do about stray voltage. (OVER)

One of those calls came from Robby Webb of Powderly, Texas, who claims to have lost more than 400 cows to stray voltage. Webb told our reporter Tim Warner that his creditors are breathing down his neck and he is awaiting the outcome of his lawsuit against a milk-machine installer.

While waiting for his day in court, Webb has appealed to his elected representatives in Washington, D.C., for an emergency Farmers' Home Administration loan. He gets sympathy, but no action from Reps. Jim Chapman and Charles Stenholm, both Texas Democrats. Maybe their real sympathies are elsewhere. Chapman annually collects \$2,000 in honoraria from the Northeast Texas Electrical Cooperative. Stenholm was on the receiving end of \$2,000 in honoraria from the National Rural Electric Cooperative and \$6,000 from the American Milk Producers Inc. in the last five years. Both congressmen say the money did not buy their influence on this issue.

Stenholm, chairman of the House Livestock, Dairy and Poultry Subcommittee, said he would be more than willing to consider legislation on stray voltage, but that no solution for it has been found.

Researchers who have studied it for 10 years disagree and say there are ways to eliminate the effects of stray voltage. The electric utilities say they are working on it, and deny that they have tried to keep the controversy locked behind the barn door.

Rep. Arlan Stangeland, R-Minn., floated a bill last year to fund \$50,000 in research, but the bill died quickly in Stenholm's committee.

The Agriculture Department has devoted some time and money to research — most of it geared to help utility companies and milk-machine installers. Little of the information filters down to the farmers. The USDA has promised to publish a brochure for dairy farmers by early 1990. *

A PENNY SAVED: Since 1950, the average American household has put away only 8 percent of its income in savings. Compare that to Japan where people save 17 percent of their income. That ability to save can help balance an economy,

Jack Anderson is a nationally syndicated investigative reporter based in Washington, D.C.

Your viewpoints

Detroit Lakes Tribune
March 5, 1989

Nov 9, 1989

The Minnesota Dairy Task Force has held seven meetings in this state since January on ways to improve the vitality of a most important state industry.

The group has one more hearing to hold before reviewing the testimony and issuing a preliminary report to the Minnesota Legislature.

State Agriculture Commissioner Jim Nichols says nearly 9,000 dairy farmers have gone out of business in this decade, while "sharp increases" continue to occur in the South. So the report is timely.

Minnesota and Wisconsin have always been the breadbasket of the dairy industry, although states like Texas, California and Florida are doing their best to undermine us.

Like all industries, dairying is not immune from the strain of competition. And, if you're going to succeed as a dairy farmer, especially a beginning one, you must keep abreast of all the latest innovations.

You have to do this even though you may never buy a hay conditioner, an upright silo or bovine growth hormones.

Why? Because you could get left in the dust otherwise. You may never inject steroids into the milk herd, but your neighbor may do it just as soon as there is federal clearance. Understanding this and other subjects is important.

This task force has a difficult job ahead, because in many ways the state is simply limited to what it can do. Dairy policy, namely prices and the supply structure, is set at the federal level.

States do best at regulating quality, production, promotion and consumption. Yet, it can serve its farmers and the consuming public better by educating them.

Paul Christ, Land O'Lakes vice president on dairy policy and a

Unexplained power outage strikes Wyoming, S. Dakota

Associated Press

An unexplained power outage left six cities in Wyoming and South Dakota without electricity for almost an hour yesterday afternoon in the wake of a five-minute "power oscillation" that affected Wyoming, Montana, Colorado and South Dakota.

"We don't know what caused it, don't know what started it," said Leslie Blythe, a spokeswoman for Pacific Power Co., based in Portland, Ore. "It seems to be stabilized right now."

All power companies sharing a network of lines in the region experienced the oscillation, said Blythe, the company's Wyoming spokeswoman. "All of the utilities are tied into a grid system," she said. "All the lines are all tied together. It may be happening in one area, but it is being seen all through the region."

B4 THE WALL STREET JOURNAL WEDNESDAY, NOVEMBER 29, 1989

TECHNOLOGY & HEALTH

Radiation Study Finds High Incidence Of Cancer Among Phone Cable Splicers

By BILL PAUL

Staff Reporter of THE WALL STREET JOURNAL. Researchers at Johns Hopkins University studying the effects of electromagnetic radiation unexpectedly found abnormally high rates of cancer among cable splicers for New York Telephone Co., a unit of Nynex Corp.

The finding is preliminary, comes from a small study, and doesn't establish any causal link between cancer and the kind of radiation given off by power lines and electrical appliances. Still, the Electric Power Research Institute, the utility industry's research and development arm, felt it was significant enough to report in writing to the chief executives of some 700 member utilities.

Indeed, while EPRI has generally found fault in the methodology of previous epidemiological studies suggesting a link between cancer and power-line radiation, yesterday EPRI had only praise for the chief Hopkins researcher, Genevieve Matanoski.

Ms. Matanoski didn't return phone calls. The study was funded primarily by

the National Institute of Environmental Health Studies.

The study of 4,500 cable splicers, who join together the bundles of wires found in telephone cables, found 40 cases of cancer, or 1.8 times the rate for the population at large. The finding comes amid growing concern by Americans that the power lines near their homes, as well as the wiring and electrical appliances in their homes, may cause or promote cancer growth. There is, as yet, absolutely no proof of that. Moreover, it isn't even certain that the cancer cases discovered in the Hopkins study were in fact caused by radiation exposure.

Still, reacting to the public outcry, last week International Business Machines Corp. pledged to reduce the amount of radiation emitted by all of its future-model computer terminals. Also, earlier this year, a Canadian utility was swamped after offering to buy the homes of anyone located near its new, high-voltage, overhead transmission line.

EPRI, meanwhile, said it is currently

spending \$6 million a year to investigate the issue, making its program by far the largest of its kind in the world. An EPRI-sponsored epidemiological study of 130,000 utility employees is due to be completed in 1992.

The Hopkins study's finding was unexpected, in part because a previous study by the same research team didn't detect a higher cancer rate among telephone-company employees nationwide.

But while the first study was of both active and retired workers, the second covered only active employees, suggesting to EPRI's radiation expert, Leonard Sagan, that younger people may somehow be more vulnerable, among other possibilities.

What also made the finding unexpected was that cable splicers are exposed to only about three times the amount of 60-cycle-a-second radiation that is found in the average home. Studies of other groups of workers with much higher exposure levels have failed to detect any increased rate of cancer, Mr. Sagan said.

"Now we need to find out why there was this difference" in the second group, Mr. Sagan said, adding that EPRI is planning to pursue specific follow-up research to clarify the questions raised by the second Hopkins study.

Electromagnetic fields may be linked to some cancers

WASHINGTON (AP) — A leading U.S. scientist says there is statistical evidence of a possible link between cancer and exposure to electromagnetic fields that radiate from the cables and wires that electrify the nation.

The unpublished findings by Dr. Genevieve Matanoski, an epidemiology professor at Johns Hopkins University, run against the grain of traditional scientific theory about the possibility of health dangers from power distribution lines.

Her conclusions fit an emerging pattern of evidence, however, that the possibility of health risks can no longer be ruled out and should be studied more closely.

"This is consistent with my judgment ... that we'll end up seeing electric and magnetic fields are cancer promoters of some kind," said Indira Nair, a physicist at Carnegie Mellon University and co-author of a recent comprehensive background paper on the issue for the federal Office of Technology Assessment.

Ms. Matanoski said in a telephone interview Wednesday that her findings were preliminary and required further testing, but that the results changed her view of the still unproven theory about a cancer link to power lines.

"I thought before that the theory was wrong," she said. "I'm not so sure any more. I'm swayed to think it's more likely than before."

Health

A major conclusion from her study of 50,000 New York state telephone workers are that there may be an increased risk of leukemia among active workers. Incidence rates for almost all types of cancer are highest among linemen, whose exposure to electromagnetic fields is the highest in the telephone worker group, the study found.

Ms. Matanoski also found exceptionally high rates of breast cancer among male technicians who work on central office telephone switching equipment. Her study found two cases of breast cancer among 9,500 central office technicians; ordinarily the incidence rate for males would be about one in 1 million, she said.

Ms. Matanoski said she expected to publish her findings early next year.

Any electrically charged conductor generates two kinds of invisible fields, electric and magnetic. Taken together, they are called electromagnetic fields. Some scientific findings have suggested these fields can interfere with the functioning of DNA and RNA, the controllers of cell reproduction, and that they may stimulate activity in biochemicals linked to the growth of cancer.

In the century since the United States began using electric power, scientists generally have dismissed suggestions of any danger to human health.

Ms. Matanoski stressed in the in-

terview that she was not yet convinced of any health danger, but said she no longer was willing to rule it out. She said further research with a larger number of workers was needed before she could be sure.

Her study found three cases of leukemia among 4,500 linemen, an incidence rate seven times higher than among other telephone workers. The overall rate of cancers of all types among linemen was nearly twice as high as among other telephone workers.

The electric power industry already has shown signs of concern about the Matanoski findings.

Earlier this month, officials of the Electric Power Research Institute, an industry group, sent letters and briefing papers to utility executives noting that Ms. Matanoski's results "may attract national attention because they suggest an increased risk of cancer."

The briefing paper called the findings "unexpected," noting that an earlier Matanoski study sponsored by the electric industry found no statistically significant link between cancer and electromagnetic field exposure in retired telephone workers.

Ms. Matanoski said she had been suspicious of her findings in the study of older workers because of the possibility that her sample may have excluded younger telephone workers who contracted cancer but died before reaching retirement age.

"Low-Level Radiation Causes More Deaths Than Assumed, Study Finds"

By R. Jeffrey Smith
Washington Post Staff Writer

Exposure to low levels of radiation, such as that from X-rays or radon, is at least three to four times—and under some assumptions, roughly 14 times—more likely to cause fatal cancer than is commonly believed, an expert scientific panel advised the federal government yesterday after a comprehensive study.

Challenging the judgment of most scientific experts in the past decade, the panel of the National Research Council concluded that there appears to be a direct, proportional correlation between exposure to penetrating, or ionizing, radiation and the risk—in short, that no radiation exposure can be considered risk free.

Members of the panel, which was created at the request of the White House science adviser's office and funded by 18 federal agencies, emphasized yesterday that these findings do not suggest significantly higher risks from occasional exposure to small amounts of radiation, including routine X-rays. The amount of radiation in these procedures is so low that even in light of the findings of increased risk, the overall danger is still low.

The panel based its conclusions primarily on recent studies of Japanese survivors of the U.S. nuclear attacks on Hiroshima and Nagasaki in World War II, who have had more fatal cancers than experts anticipated. It also took account of new studies exposing laboratory animals to radiation and employed more-sophisticated scientific models of the link between radiation and cancer.

The effect of its conclusions is to at least quadruple estimates of the number of radiation deaths expected among workers in the nuclear power and nuclear weapons industries, those who frequently undergo medical procedures involving radiation and those who are routinely exposed to radioactive elements in certain natural gases, building materials or tobacco.

The study found, moreover, that fetuses exposed to low levels of radiation between the eighth and 15th weeks of pregnancy have an appreciably higher risk of being mentally retarded than was previously known.

"The average citizen should not view this as a source of great concern," said Arthur C. Upton, the panel chairman and director of the Institute of Environmental Medicine at New York University. He said the study confirmed "earlier reports that we really don't know there is a safe level of radiation" but that X-rays and other medical treatments involving radiation clearly remain appropriate when "the benefits outweigh the risks."

While the panel did not formally examine the adequacy of existing government standards for radiation exposure, Upton and other members said they expect limits to be tightened in the United States and other countries after the study is reviewed. The tightening could increase the cost of producing nuclear weapons and power and complicate the government's cleanup of old reactors or nuclear waste dumps.

"I think there will be some revision," Upton said at a news conference at the National Academy of Sciences, which is the council's parent body. Regulators "live in a glass house . . . and the public is watching, so I expect them to trim their sails in a way that is responsive" to the study.

The panel cautioned that its conclusions about radiation risks are subject to continuing uncertainties and vary according to the age and sex of individuals exposed. It said, for example, that men are more likely than women to develop fatal leukemia from radiation exposure, while fatal solid tumors are more likely in women.

Those who receive a significant, short-term dose of radiation are considered to be at greater risk than those who receive smaller doses stretched over a long time, the panel said. Those who receive significant doses during childhood or adolescence are also at greater risk than those exposed as adults.

The new risk estimates are a significant revision of a report prepared by a different National Research Council panel in 1980. That panel was racked by dissension and could not agree on a specific way to relate exposure and risk, but came up with a range of estimates that helped guide the Nuclear Regulatory Commission and the Environmental Protection Agency (EPA) in writing regulations.

The new estimates, which tend to confirm the judgment of dissenters to the 1980 report, indicate that the fatal cancer risks are three to four times greater than the highest numbers assumed then and roughly 14 times greater than the lowest numbers assumed then, according to the panel's 421-page report.

One implication is that the number of people expected to die from cancers caused by the 1986 reactor explosion at Chernobyl in the Soviet Union will be at least four times greater than previously estimated, several panel members said. Instead of the 17,400 fatal cancers throughout the Northern Hemisphere projected last year in an article in *Science* magazine, the actual number of deaths from Chernobyl may be over 70,000.

Many experts were surprised by the magnitude of the shift in estimated risk, which they had expected merely to double. Data on which the study was based have essentially all been available since 1985, creating substantial scientific discussion and anticipation of the \$860,000 report.

Part of the report reflects results of recent studies of 76,000 survivors of the Hiroshima and Nagasaki bomb blasts, who have been closely monitored by a joint U.S.-Japanese commission established after the war to measure the long-term effects of radiation on humans.

It also reflects extensive new investigations of the amount and type of radiation emitted in the bomb blasts, as well as the effects of shielding provided by buildings and other structures in those cities at that time.

Researchers, who tried to recreate the original bomb designs, discovered that the amount of radiation they emitted when they exploded was generally less than originally thought. This means the cancers that have resulted must be attributed to lower radiation doses. Also, as the surviving population has aged, far more fatal cancers have developed than scientists expected, including cancers of the breast, lung, stomach, ovary, throat, colon and bladder, as well as leukemia, a blood cancer.

More people than expected who were exposed to the blast radiation before birth were mentally retarded. The incidence of genetic defects passed by the survivors to their offspring has not increased unexpectedly, however, causing the panel to stick with earlier risk estimates for these conditions.

To put the new estimates in concrete terms, the previous panel said in 1980 that roughly 25 to 119 fatal cancers would be caused by the exposure of 100,000 persons to 0.1 REM of radiation annually over a lifetime. A REM is a standard unit of measurement that means "rad [another unit of radiation] equivalent in man," and 0.1 REM is an amount equivalent to the average annual radiation each person receives from cosmic rays.

The new study suggests instead that this exposure causes between 520 and 600 fatal cancers. Uncertainties in the analysis mean the true number could be twice as high or half as much.

The new study also states that the incidence of fatal cancers increases in proportion to exposure levels. For a group of 100,000 exposed annually to a much larger amount of radiation—1 REM—between 2,880 and 3,070 fatal cancers are predicted to result.

These numbers do not include those who contract cancer but who die of something else, which experts say is roughly an additional 50 percent of these totals.

The current U.S. occupational health standard—set in 1961—bars nuclear workers from receiving more than 5 REM annually, although most workers routinely receive less than one REM. A routine chest X-ray, in contrast, exposes individuals to just 0.06 REM, a level that Upton said would increase an individual's risk of fatal cancer by one in a million.

Exposure to radon gas in homes and domestic water supplies was also said by the panel to pose a significantly increased risk of cancer, as well as exposure to radioactive building materials and agricultural products. "Smokers are additionally exposed to the natural radionuclide [radioactive element] polonium-210 in tobacco, resulting in the irradiation of a small region" of the bronchial tube by a relatively high dose, which "may cause an increased risk of lung cancer," the study said.

Warren Sinclair, president of the National Council on Radiation Protection, said, "I think the report overall is very good." His group, which is chartered by Congress to advise on radiation standards, will likely urge that current regulations be tightened to reduce health risks, he said.

Sinclair predicted this would affect the operation of nuclear power plants, which use a limited number of highly skilled workers to perform jobs that expose them to radiation at levels near the current occupational limit.

A representative from the U.S. Council on Energy Awareness, formerly known as the Atomic Industrial Forum, attended the press briefing and handed out a critique of the report that emphasized the uncertainties associated with the new risk estimates.

Thomas Cochran, a nuclear physicist with the Natural Resources Defense Council, an environmental group active on radiation issues, said, "I don't have any fault with the report's conclusions. The issue is how you translate this into policy."

He said the group would probably cite the report in pressing for a significant reduction in the standard for occupational radiation exposure and in mounting a campaign against a proposed relaxation of federal regulations concerning low-level, radioactive trash.

Richard Guimond, director of EPA's Office of Radiation Protection, said the new study justifies "caution" in proceeding with the proposed regulations, which would allow various wastes to be disposed in common landfills without government scrutiny if the owners certified that the wastes generated extremely low levels of radiation.

PENNSYLVANIA. *Stray voltage.* In the case of *Slater v. Pennsylvania Power Co.*, 557 A.2d 368 (Pa. Super. 1989), the Slaters, a dairy family, filed a tort action against an electric utility for economic injuries. The Slaters had noticed in their decline in milk production, health problems, and unusual behavior. Upon investigation, stray voltage was found. The utility suggested several changes to be made at the Slaters' expense to solve the problem, to no avail. Subsequently, the Slaters' electrician disconnected a ground wire that ran from the utility's pole; the stray electricity disappeared. When the wire was reconnected with modification, the stray voltage problem did not recur.

The jury awarded the Slaters damages of \$81,374.41. The utility appealed, arguing that it was entitled to judgment n.o.v., that there were errors in the jury charge, and that the proof of damages was inadequate.

At trial, the Slaters argued that the utility was negligent in supplying power to their farm and in its failure to immediately reduce or eliminate the stray voltage. The utility argued that stray electricity is an inherent part of power distribution and presents a problem only when the amount is too great.

The utility conceded at trial that the amount of stray electricity was too great in this case. Based upon the position taken by the Slaters at trial, the jury apparently agreed that the utility was negligent. The appellate court found that that was a reasonable result from the evidence presented. Accordingly, denial of the motion for judgment n.o.v. was proper.

On the issue of proof of economic loss, the appellate court noted that the Slaters had the burden of proving damages by a preponderance of the evidence, but that they needed only to provide the jury with a reasonable amount of information to enable them to estimate damages without resorting to speculation. In this case, proof of economic loss could be established by testimony of the dairy farmer himself, relying on personal knowledge and books and records of the business.

At trial, the Slaters' jury instruction stated that anyone who provides or supplies an inherently dangerous instrumentality, such as the supplier of high-voltage electric current, is required by law to use the highest degree of care practicable to avoid injury to anyone who may lawfully be in the area. This instruction was based on two Pennsylvania cases, *Kintner v. Claverack Rural Electric Cooperative*, 329 Pa. Super. 417, 178 A.2d 858 (1984) and *Schriner v. Pennsylvania Power and Light Co.*, 348 Pa. Super. 177, 501 A.2d 1128 (1985).

The utility argued that the highest degree of care applies only to injuries suffered by humans, but did not cite any cases in support of this distinction. The appellate court held that the two cited cases were the law in Pennsylvania and that the standard of care does not vary when the damages consist of property

NSP SUIT

Producer says stray voltage hurt milk production

GAYLORD, Minn. — Green Isle dairy farmers, who say stray electrical current substantially cut their cows' milk production, have been awarded \$1 million by a jury.

Dale and Gloria ZumBerge and their son, Steven, had sued Northern States Power Co., claiming NSP failed to warn them about stray voltage — errant electricity that enters the ground from grounded electrical distribution systems. They also say NSP failed to bring it under control once it was discovered.

"It took a tremendous load off our shoulders," Dale ZumBerge says.

Sam Macalus, NSP spokesman, says the company may appeal. NSP's position "is that the evidence in the case doesn't demonstrate the reduction in dairy production was due to stray voltage."

Ag Week 10/22/90

LOS ANGELES TIMES
12/24/90

Cancer and Power Lines — an Uncertain Connection

■ **Health:** A 1979 study linked magnetic fields with childhood disease. But the issue is far from settled.

By MYRON LEVIN
TIMES STAFF WRITER

When a 1979 study indicated that childhood cancer rates were higher in families living near high-current electric power lines, scornful utility officials and many scientists insisted that electromagnetic fields from power lines couldn't possibly affect human health.

But a follow-up study supported the findings, concluding that children living near high-current lines were 1.5 to 2 times more likely than others to get cancer. Other studies have found that workers in electrical jobs—such as utility linemen, power station operators and electricians—have higher rates for brain cancer, leukemia and lym-

phoma, the same cancers implicated in the childhood studies.

Still, the issue is far from settled. There are ambiguities in much of the research, and other studies have found no link between illness and electric and magnetic (EM) fields. Nor does anyone know the mechanism by which these fields, even weak ones, may cause harm.

The controversy is especially perplexing because few things seem more benign or indispensable than electricity, and it is hard for some scientists to envision demons lurking in electric wires.

Robert Adair, a Yale University physics professor and leading doubter, said investigating the effects of EM fields is like looking for

Please see **CANCER, A20**



Cable leakage may pose problems

By DENNY WARRICK
P.O. Government Editor

CABLE TV SIGNAL leakage soon could be a serious problem for some cable system operators nationwide, but the Watertown Cable TV Company is trying to be one step ahead of a summer deadline.

Some local cable subscribers have already learned the company is seriously battling the problem.

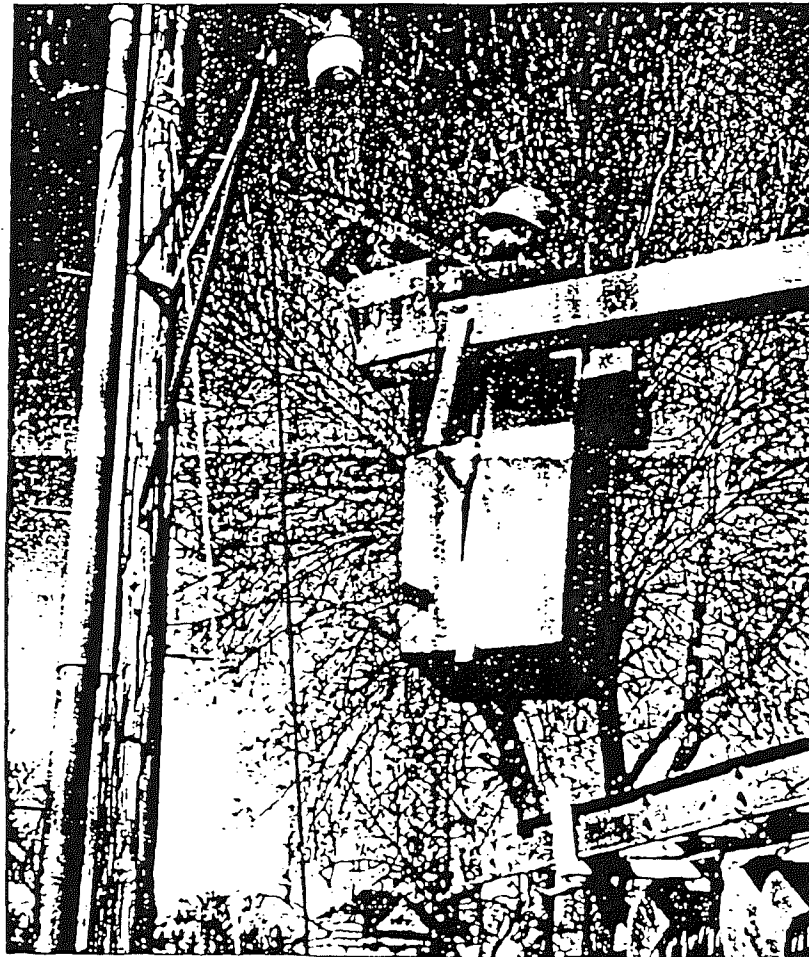
Steve Schirber, cable system manager, said the company has begun a vigorous campaign to combat cable signal leakage before a July 1 federal regulation takes effect. Although leaks sometime involve lines outside homes, company workers have visited homes when detectable leaks originate from inside the residence.

He predicted that cable leakage will be in the news more often as July 1 gets nearer.

"WE CAN CHECK everything outside from the pedestal to the house, but if the signal is still there, we have to go inside," Schirber told the Public Opinion.

If no one is home, workers leave a yellow-colored card on a doorknob. The card explains that a problem has been detected during the required testing and "that someone in your home there is a loose cable connection, a damaged cable wire or an improperly attached piece of equipment."

The card says the Federal Communications Commission "requires us to monitor this situation as some of the frequencies we use are the same frequencies that airplanes, police and safety officials use. Our frequencies (if leaking) could interfere with these other users and it could prove to be dangerous and hazardous."



LEAKAGE CHECK — Bob Spilde, chief technician for the Watertown Cable TV Company, checks for leakage from the cable system near an amplifier and outlets to several Watertown

homes. Company workers have found about 250 leaks since Jan. 1 while trying to meet a July 1 federal government mandate. (Public Opinion photo by Denny Warrick)

homes. Company workers have found about 250 leaks since Jan. 1 while trying to meet a July 1 federal government mandate. (Public Opinion photo by Denny Warrick)

The card asks the subscriber to contact the cable company within 48 hours so repairs can be made. Otherwise, the company will disconnect the customer until "we can inspect and repair the fittings, wires or attachments."

Schirber said customers "have been pretty good about getting back to us."

BOB SPILDE, THE company's chief technician, said workers have found about 250 leaks since Jan. 1. About half of the problems have been outside residences.

Problems inside the home often involve a wire being incorrectly connected to a television or the cable system or a broken wire on small transformers supplied by the company that connect to some televisions.

Other problems have involved loose cable fittings, incorrect hookups and the use of an inferior cable product. In one instance, a dog had chewed on the cable and damaged it, Schirber and Spilde said.

Leakage can occur "anytime you have a break in the shield (wire) and then it can act as an antenna and transmit the signal," Spilde explained.

In some instances, the subscriber does not call the company, but a worker discovers during a followup check that the problem is gone.

Besides allowing cable signals to escape, a leak can allow unwanted signals to enter the cable system, degrading the system's performance, Schirber said.

"WE TAKE THE problem very seriously ... because it's something we should do for safety and for our customers" even if not being mandated by the federal government, Schirber continued.

The company has earmarked \$10,000 to purchase equipment to detect low levels of leakage and has spent additional money to train workers. The work has become so intensive that Schirber said the firm may have to hire another employee.

"We used to do it in the winter, but it's become more of a full time task because of the deadline that is coming," Spilde added.

TO: TERF MEMBERSHIP

FROM: JOAN DAGGETT, TREAS. TERF, WI Chapter

RE: JUNE 18, 1990 STRAY VOLTAGE MEETINGS HELD FARM BUREAU BLDG., MADISON, WI

The special Stray Voltage discussion session was broken up into three groups which focussed on the three major discussion topics pointed out in the correspondence/memorandum from Jim Dohner, DATCP dated May 11, 1990 in our first newsletter:

1. Is there a need for a financial grant or loan guarantee program to assist farmers in implementing corrective measures to rectify stray voltage problems?
2. What outreach education and technical materials are still needed to assist farmers, veterinarians, utilities, electricians, ag educators and others in dealing with stray voltage?
3. What should the state's role be in regards to stray voltage research? What, if any, types of research projects need to be addressed?

The Farm Newspapers state the following:

The Country Today

Page A10

Wed., July 4, 1990

Education, research are termed crucial for solving voltage issues

Madison

Solving stray-voltage problems will take more research and more education, according to participants in a stray-voltage discussion session.

Farmers, utility representatives, legislators, electricians, scientists and other concerned people met during the Madison session, which was called in June by Alan Tracy, secretary of the Wisconsin Department of Agriculture, Trade and

Consumer Protection.

Participants considered the need for a financial grant or loan guarantee program to help farmers rectify stray-voltage problems; outreach education and technical materials to assist groups in dealing with stray voltage; and stray-voltage research and state involvement in such research.

The participants formed three groups to discuss the issues, then met together at the end of the morning to discuss their conclusions.

All three groups agreed more research is needed, especially on-farm research. One group leader said there needs to be an outlet for research done on farms by farmers

"Information that comes from professors and engineers has a way to get out through publishing in journals," said Charles Jones, and information from farmers does not

He said electromagnetic radiation is not fully researched and needs more research. But there is no need to reinvent the wheel, he added. There is research on stray voltage and other electrical issues published by several engineering societies, he said, which needs to be compiled and reach a greater audience among those concerned with stray voltage.

The groups agreed people need to be aware that stray-voltage problems do not necessarily indicate bad management.

"The farmer has got to be educated that there can be such a thing as stray voltage and it can cause herd health problems," said Brad Kolpin, a farmer who has been active on the stray-voltage issue.

"A lot of farmers have spent themselves broke buying new equipment, getting new feed consultants and buying feed when what they had was a stray-voltage problem," Mr. Kolpin said. "There is a stigma out there and farmers don't want to go through the hassle. We need to stress the reality of stray voltage and thereby remove the stigma."

One suggestion concerned developing video instructional materials to alert farmers and veterinarians to animal behavioral problems and perhaps on the correct way to install and use a volt meter in the dairy barn.

Wally Daggett, another farmer who has been an advocate in the stray-voltage issue, said there should be one piece of stray-voltage law the state can work with. He said the ag department needs someone on staff, preferably an electrical engineer, who could visit farms when problems were reported.

One group suggested a state law to require farmers to install volt meters in their dairy barns in order to keep their dairy permits.

Paul Proctor of Wisconsin Power and Light suggested educating high school agriculture students. Making stray-voltage assessment a class assignment might be a way for farmers to learn more about the issue and determine if they have it, he said.

The Country Today — Jan Shepel

Stray voltage frustrations Additional farmer and electric co-op representation possible on SVAT's advisory council

JOAN SANSTADT

MADISON

Restructuring of Wisconsin's Stray Voltage Advisory Council to include additional farmer and rural electric cooperative representation is likely.

Meeting Monday, the council voted to recommend the Department of Agriculture, Trade and Consumer Protection (DATCP) name additional members for these areas, perhaps in time for the next meeting on Sept. 24.

Another recommendation centered on information collected on farms inspected for stray voltage problems.

Jeff Lyon, Wisconsin Farm Bureau, president of the advisory council, said "as a result of public comments here today, I want to recommend the Stray Voltage Analysis Team (SVAT) leave a printout (or computer disk copy) of the electrical readings they recorded with the farmer before they leave the farm." SVAT members pointed out leaving a paper copy of their findings could be difficult, but a copy of the computer disk would be an alternative.

Speakers during the public comment portion of the meeting expressed frustration with efforts to remedy stray voltage problems on their farms. Lyon's efforts to allow each speaker enough time to express his views stretched the comment portion of the meeting. "But, when I looked out the window and saw what a nice day it was, I realized the people who had made an effort to show up at the meeting felt strongly and deserved a chance to have their say," Lyon said.

Frank Braun, Richland County farmer, said since his farm had been disconnected from the utility system and he is operat-

ing with generators "our cows chew their cud. What happened on our farm is unbelievable," he added.

"I've studied physics on my own for 35 years," Braun said, "and what we need is for utilities to get the primary off the neutral and let farms run on their own neutral. Have you ever fixed any farms?" Braun demanded of the SVAT team.

Bernard Fargen of the Richland County Rural Electric Cooperative, said Braun's farm was disconnected by the utility because of unsafe conditions "for both animals and humans."

Fargen said these conditions were created when Braun deliberately cut the grounding on the utility side of the distribution system, thus creating the safety hazard.

A March disconnection notice was extended until the SVAT team could visit the farm, Fargen pointed out. Although the SVAT team did not recommend disconnection, Fargen said, "they did recommend removal of an isolator. They (SVAT) also pretty much confirmed everything we've been saying for the last five years."

Sometimes rural electric cooperatives are incorrectly criticized for lack of regulation, Fargen said. "Since we're funded federally under the USDA, we receive minimum regulations from them. But we are also required to follow state requirements anytime they exceed the federal ones," Fargen added.

"The bottom line is safety," Fargen stressed.

Other speakers said they were outraged at the laxity in enforcement of electrical codes. Jeff Weber, Hartford, said he wanted strict enforcement of the electrical code and certification of all electricians. "I can hire an electrician or a dairy equipment installer and that person can be incorrect in his work, and yet he is not held responsible. It's the guy on the end, the farmer, who is harassed all the time."

"We need to get utilities to admit they are causing some of the problems," We-

ber added "You're late inspector. If you don't get one, I'll all be buying your milk from Illinois (producers)."

New London farmer Elmer Keller recommended firing the Public Service Commission (PSC) and the SVAT team. "Put them right in jail," he said. "Get state and federal code enforcement and stop the bribes. Then we won't have any problems," he insisted.

Lyon said some of the problems being expressed were not in the jurisdiction of the SVAT Advisory Council. "We make recommendations to the DATCP regarding the SVAT team. We are not an advisor to the PSC," he said.

Wallace Daggett, Random Lake farmer and SVAT Advisory Council member, asked that copies of stray voltage research projects conducted with Hatch Act funding at land grant universities be obtained and made available to council members.

The council decided to invite Leo Walsh, dean of the College of Agriculture and Life Sciences, to attend a meeting and discuss a possible research project for the Madison campus.

Daggett suggested milk processing plants, such as those of Milwaukee Milk Producers or AMPI, might also have some input on stray voltage research projects.

On-farm stray voltage research emphasized

JOAN SANSTADT

MADISON

A forum on stray voltage Monday morning found three discussion groups agreeing on the need for more research, but with differing ideas on where the research should be focused.

Participants in the discussion groups were asked to look at three questions:

- Should there be a grant program to provide financing for farmers to make electrical repairs to their farms?

- How should outreach education for utilities, electricians, veterinarians, ag educators, farmers and agribusiness be conducted?

- What's the state's role in stray voltage research?

Conclusions of the three groups were reported in a general session. Research, the participants said, was already going on in many areas and needed better dissemination. "We don't need to re-invent the wheel," Random Lake farmer Wally Daggett said, adding current research includes "a good mixture of utility, academic and farmer" efforts.

Some research disagrees with other studies elsewhere, which can be a plus factor, the group said. Universities receive most of the utility research funds, especially Cornell University and the University of Michigan. The groups said this research needs to be balanced with input from farmers and electricians, as well as other utilities and universities.

The knowledge of farmers who are on the farm every day and can make constant observations must not be downplayed, they emphasized.

Among the topics singled out for further research were primarily on the farm, especially neutral lines with ground currents, gas lines, utility grounds, telephone lines and isolators. "We need to get the results published, especially research conducted by farmers," the group said.

"Every farm is different and may require different solutions," spokespersons for the discussion groups said.

Farmers in each group spoke of the sensitivity of being called a poor manager if they have stray voltage problems. "If a farm has stray voltage, there isn't a lot of time left for farm management," they said.

Inspection of farms by a DATCP staff person, such as an electrical engineer, would be a help in most instances, the groups said.

Better attention needs to be paid to observations of cow behavior where stray voltage exists.

Bankers need better education about stray voltage and members of the groups said some bankers are refusing to go along with even guaranteed loans (such as WHEDA loans) where stray voltage exists.

The forum's conclusions will be considered by the DATCP as it prepares its next biennial budget.

'Voltage' Ideas Plentiful, Money Scarce

By Joel McNair
State Editor

While lots of good ideas are being broached about what Wisconsin can do to solve stray voltage problems, state agriculture department officials are warning that there won't be much money available soon to make those ideas reality.

The department held a "discussion session" Monday in Madison to hear what farmers, utility officials and others think the state should be doing to solve voltage problems. It was an opportunity for the department's new leadership to learn more about voltage and prepare proposals for the agency's next two-year budget.

While new to the top spot, Alan Tracy

wasted little time in offering a warning to the audience that sounded very much like those offered by his predecessor as ag secretary, Howard Richards.

"We will be working with a limited budget," Tracy remarked.

Joe Tregoning, the new executive assistant at the ag department and a former state representative from Shullsburg who dealt with many an ag department budget request, was even more succinct after Monday's session.

"When we're talking about the amount of money there, people have been talking about, that's going to be difficult to do," says Tregoning.

People at the meeting came up with a

veritable slew of ideas for what could be done to help farmers suffering from stray voltage. Some suggested that the ag department take a more active role in providing a "neutral" electrical expert who could come to a farm quickly and of a judgment as to the source of a problem and possible means of solving that problem.

The department could do more to provide information to farmers, electricians and power companies, it was suggested. More on farm research is needed, others said.

"I think there needs to be a grant program," said Brad Kolpin, a Westfield dairy farmer. Kolpin estimates that 10 to 15 percent of the state's dairy farmers are suffering severe financial problems caused by production losses stemming from stray voltage.

"A lot of these guys are going out fast," Kolpin asserted.

Another volt activist, Wally Daggett, a Random Lake dairyman, echoed Kolpin. "We've got to stop foreclosures of farms with stray voltage," said Daggett. "I don't know if that means grants or a moratorium on debt."

Tregoning says the farmers are hampered by the lack of agreement

within agricultural, electrical company and research segments about the causes, effects and best means of solving voltage problems.

The ag department and the Wisconsin Public Service Commission have collaborated to form a Stray Voltage Analysis Team (SVAT) that visits farms with suspected problems. The SVAT has made good strides after suffering a slow start, many farmers say.

But efforts to extend the state's effort beyond SVAT have stumbled. The Stray Voltage Task Force, a group picked by Richards to guide the department and other state agencies, is splintered by opposing views from farmer, research and utility interests. Richards attempted to disband the group at its last meeting early this year and said the state couldn't do much more if volt interests continued to be divided.

Tregoning noted that Governor Tom Thompson and the Legislature have been impressed by the voltage lobby's efforts to seek state assistance.

"We have to have a pretty solid case, but at this time the field is divided," Tregoning commented. "We are going to be kicking some of these things around, however."

Rural Harrold

Professor finds abnormal electricity at farm house

By BOB MERCER
American News Writer

PIERRE — A college professor said Wednesday that he found unusual electrical fields at the home of a rural Harrold family who say they had health problems and saw a compass point south and a fluorescent light bulb glow in a person's hands.

Property owners Peggy and Jim Lappe brought Concordia College physics professor Duane Dahlberg to a meeting at the Capitol with state and congressional officials.

Dahlberg, from Moorhead, Minn., said he has spent the past seven years researching stress problems of dairy herds in areas that have underground power lines. He said the symptoms disappear when the lines are moved.

The Lappes since 1988 have struggled with Ree Electric Cooperative of Miller about a transformer that sits 28 inches from their farm house. The family moved out

in April 1989. The co-op now has shut off the power.

Dahlberg said he visited the Lappe property and monitored high levels of electrical frequencies in the ground, even though the electric line is dead.

"None of those things should be there. They are not naturally occurring," Dahlberg said. "I could not live there. I absolutely could not live there."

Peggy Lappe said she had trouble breathing while living at the house and went to the bathroom six to eight times a night. She said her husband and their 8-year-old daughter also experienced health problems.

Lappe said they decided to move after conducting some basic tests. She said a compass spun backward and a fluorescent bulb lit up at various points in the house. "We have about 12 to 15 witnesses who saw what we saw," she said.

The story was not challenged by (See HARROLD, Page 3A)

Harrold: Professor thinks house would make a good research site

(Continued from Page 1A)

Bill Hughes, an electrical scientist and vice president at South Dakota School of Mines and Technology.

"Obviously if a fluorescent bulb lights, there is pretty strong electro-magnetic radiation in the air," Hughes said.

Congress has held hearings on

electro-magnetic fields in recent years and there is growing concern around the world about the issue, according to Dahlberg.

"As yet, and I will say this categorically, no one has pinpointed the cause and effect relationship," he said. "I find cases now (that) are virtually Love Canals without the

chemicals.

"This is a societal problem. This is not an issue to blame somebody," he added.

The Lappe house would be a good research site, Dahlberg said. "It could be financed by federal or state sources. The money has to be spent eventually," he said.

Letters

Marysville Daily Forum

9/4/90

Cooperative addresses concerns of residents

To The Editor:

A few area residents have recently voiced their concern about possible health effects of electromagnetic fields (EMF) from a 345 KV electric transmission line planned for the area. We not only listen to, but have encouraged these kinds of comments and have addressed them many times in public meetings as well as published notices and fact sheets provided to local residents. To continue this commitment to keep the public informed, following is additional information that will help clarify this issue:

•The Harvard Medical School Health Letter of March 3, 1990, states:

"It is exceedingly difficult to find clear evidence of injury, disease or death attributable to these extremely low frequency electromagnetic (EMF) fields."

•The National Cancer Institute in a March 1990 statement from its office of Cancer Communications states:

"There is still no evidence that EMFs cause or promote oncogenic

(cancerous) transformation of normal cells...Studies of laboratory animals exposed to EMFs have not shown any increased risk of cancer."

•The top scientists in the nation on this subject seem to agree that there is no need for alarm — no conclusive scientific evidence has established that high voltage lines present a health threat to people or animals.

•The magnetic field created by this line is well below the only standard set in the United States — established by the state of Florida. Florida's maximum allowable field is 150 milligauss at the edge of the line's right of way, about 75 feet from the center of the line. In contrast, this 345KV line will be approximately 16 to 22 milligauss under typical load conditions. At 400 feet from the line, the approximate distance the nearest building is located, under the same normal conditions, the milligauss readings are projected to be one or less.

•EMF readings inside homes, from house appliances, are typically higher than the transmission line. Following are some typical magnetic field comparisons:

345KV line at 400 feet — less than 1 milligauss
Microwave oven at one foot — four to 20 milligauss
Household wiring — up to 10 milligauss
Electric shaver — 15 to 1,500 milligauss

The seven utilities participating in this construction project consider the line as vitally important to the people of northwest Missouri. The line will meet the increasing usage of electricity in this area — for today and tomorrow. Despite declining population in the area, electrical usage is increasing approximately 2.5 percent — as a result of increased per capita consumption. The line will also help hold down electric rates by allowing utilities to buy and sell power at favorable rates. In the case of an emergency electrical outage, this line will also provide backup service to assure residents a dependable, continuous flow of electricity.

Sincerely,

Max Cates
Director, Marketing and Communications
Associated Electric Coop, Inc.

Questions on power line

Editor, News-Press/Gazette:

I am writing in regard to the 345-kilovolt power line running from Brownville, Neb., to Fairport, Mo. Several of the landlords and I have been doing research on the effects of this line. What we have been finding is not very reassuring. The electromagnetic field from this line has been linked to everything from cattle abortion to increasing the probability of cancer to Sudden Infant Death Syndrome, among many other things.

My wife and I purchased some ground last fall on which to build a house and raise horses. Now, the electric companies are taking our ground, and there is no way we can build our home or raise horses on this land. When I talked to the company, they said they thought about going around us, but decided not to.

This is only one problem. The line comes within a quarter-mile from Fairfax, Mo. It has been argued that a fluorescent light bulb will light up a quarter-mile away, just from the electricity leaking off the line.

Most of the research being done on electro-magnetic fields is being done by electric companies. I believe this is the same as letting the fox guard the chickens.

On August 25, we will hold a town meeting at the Fairfax School. We need your help and support in getting this situation cleared up, so we can have a safe environment for all. Thanks for your help and consideration!

8/5/90

PHILLIP YOCUM
Fairfax, Mo.

Countryside

In search of stray voltage Minnesota, Wisconsin renew interest on controversial issue

TIM KJOS
Staff Writer

Last month, a Sibley County jury awarded a dairy family \$1 million in damages for stray voltage problems.

The jury found the utility company negligent in failing to correct a problem that it had earlier diagnosed. The award is an isolated instance, the problem isn't. The number of troubled U.S. dairy operations is unknown, but is estimated to run in the hundreds, if not thousands. The Wisconsin Public Service Commission is actively trying to find answers to the "gray areas" of stray voltage issue, with assistance from Concordia College physics professor Duane Dahlberg and other noted experts.

Dahlberg is convinced that studying all forms of stray voltage is essential. He points to direct current electricity transmission, electromagnetic fields and ground currents as possibilities for the health and behavioral problems experienced by livestock and humans.

Dahlberg is at the forefront of those

individuals suspecting there are other causes for stray voltage than a loose electrical motor wire or rusted ground rod.

He was barraged by telephone calls last week after Wisconsin public television aired a three-part program on the subject.

At the other end of the spectrum are the beginnings of a study by several Minnesota departments and agencies.

They want to know, first of all, what the utility companies have countered in the past several years and how successful they were in solving the problems for individual dairy farmers.

Bill Coleman, director of the Minnesota Agriculture Department's dairy and livestock division, acknowledges stray voltage is a problem, "but what we don't have a handle on is how extensive it is or how much work has been done on it, and how much still remains out there."

A major question in Coleman's mind is whether the issue is traditional stray voltage or the result of some other phenomenon, such as that theorized by Dahlberg.

The Department of Agriculture is

joined in its latest efforts by the Minnesota Public Utilities Commission, Department of Public Service, Minnesota Pollution Control Agency, Department of Health and Environmental Quality Board.

Gov. Rudy Perpich earlier sought recommendations from these bodies so the state could develop a policy position on how to respond to problems.

Mike Michaud, a PUC electrical engineer, said more information is needed before recommendations can be made.

Part of that undertaking will be to better define stray voltage, and whether it is caused on the farm or off it.

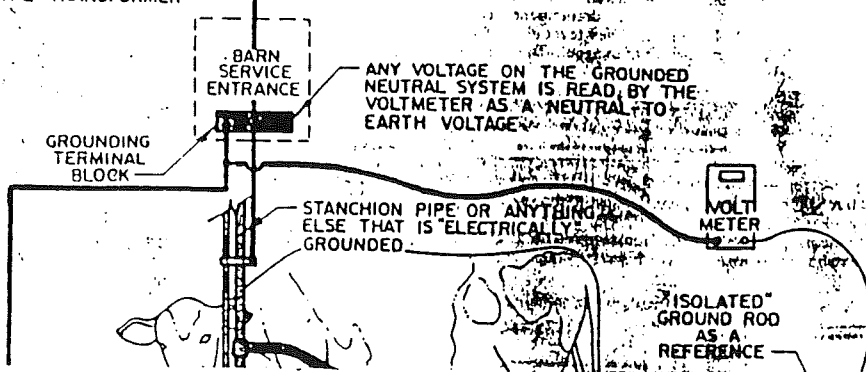
To begin, the state wants to know the scope of the problem, and the electrical companies' experience with it.

"There's not enough data accumulated anywhere that allows us to focus on whether the problem is growing or not, or just how extensive it is," commented Michaud.

The state is on a loose time

Voltage to page 2B

SECONDARY NEUTRAL FROM
THE TRANSFORMER



Voltage

continued from page 1B

frame for acting. Electrical companies are tentatively scheduled to receive the surveys in late December.

The general public will also be given an opportunity to testify, including farmers, dairy processors and independent consultants.

The last time a survey was conducted by Coleman's division was 1986. The results were inconclusive.

However, they received sufficient response to indicate that stray voltage was a problem on about 300 of the 1,000 or so respondents.

Today, 100 of those operations are out of business. A person can only speculate as to the reasons.

Says Coleman, "I imagine a lot of it probably had to do with the economics of trying to deal with a situation like that."

Dahlberg examined those results, but was not provided the names or addresses of the respondents. He feels the survey wasn't scientifically con-

clusive.

He is also critical of the Agriculture Department for not taking a more aggressive role on this issue several years ago.

Dahlberg theorizes that inadvertent, non-intentional uses of electricity could be a leading cause for some of the problems.

Michaud contends that each dairy farm's problems with stray voltage are unique to their situation. Some difficulties are easily solved, others not.

He says farmers will need to do constant maintenance of their equipment to avert potential problems.

If the problem is something more than just faulty grounds, perhaps the entire electrical transmission system

itself, Michaud said that poses a more difficult predicament.

"The utility grid has been built up over a lot of decades. If there are changes required to that system they certainly won't happen overnight," suggests Michaud.

Dahlberg hopes to have some input with Minnesota's interagency survey.

He predicts that within time, stray voltage will be as much a concern to consumers as is waste recycling, water quality and the environment in general.

The Wisconsin PSC is considering approaching the state Assembly for \$1 million to do a two-year study on stray voltage.

Fenceline to Field

by LISA AXTON
BECKER COUNTY EXTENSION
AG AGENT



EPA report links cancer, electromagnetic fields

Dec 14, 1990

By The Associated Press

An Environmental Protection Agency report linking electromagnetic fields to leukemia and brain cancer in children will be released next week after being held up by the White House science adviser, the EPA said Thursday.

Some EPA scientists said the White House was wrong to delay the report. But the White House science adviser's office told the agency it was concerned the report would alarm the public, EPA officials said.

Similar reservations were expressed by Assistant Secretary of Health James Mason, the EPA officials said.

"They were concerned not about the accuracy of the report," said Robert McGaughy, who supervised the report's preparation. "They were concerned about how people would react to the news. There is a concern that people will take too seriously the suggestions that there may be some connection with cancer."

Neither White House science adviser D. Allan Bromley nor Mason were available for interviews

Thursday, their offices said.

The report looked at all kinds of electromagnetic fields, from those produced by high-power electrical transmission lines to those produced by household appliances.

Virtually everyone is exposed to such fields every day.

Epidemiological, or statistical, studies have linked residential exposures to childhood cancer and occupational exposures to cancer in adults, said David Savitz of the University of North Carolina in Chapel Hill, the author of one of the most important of those studies.

Laboratory studies have suggested that living cells can respond to electromagnetic fields, and researchers have hypotheses as to why the fields might theoretically cause cancer, he said.

"There are credible scientific suggestions of adverse health effects from these exposures, but the overall body of evidence is not conclusive," said Savitz.

The EPA report is a review of all existing studies on electromagnetic fields and cancer.

A draft prepared last summer

concluded that the studies "show a consistent pattern of response which suggests, but does not prove, a causal link" between household power distribution systems and certain cancers in children.

The children's cancers were leukemia, brain cancer and lymphoma, the report said.

The draft has been revised once, but "our current conclusions are very similar," McGaughy said.

David Bayliss, one of the authors, said he was frustrated by the delay in releasing the report. He said it had been scheduled to go out Nov. 27.

"What is the use of having an Environmental Protection Agency if you're going to withhold information from the public?" Bayliss said. "I thought the EPA was for letting people know about health problems, or possible health problems."

McGaughy said the report was delayed because of questions raised by Bromley, and that Mason later expressed some of the same objections.

Voodoo voltage

Stray voltage. Most people in agriculture have heard about it. Contrary to what you may have thought, it just hasn't gone away.

It was a popular subject about four years ago. Scientists pursued it with Sherlock Holmes-style intensity. Dairy producers routinely reported freak occurrences on their farms. Politicians went out of their way to visit these farms for the media hype.

But all of a sudden, the subject became old hat.

Today, the Wisconsin Public Service Commission is doggedly pursuing new leads. The commission wants to put the issue back on the legislative agenda, hoping the Assembly will grant \$1 million for a two-year study.

In this state, several departments and agencies have been directed by Gov. Perovich to get detailed information from the utility companies as to the extent of the problem, and what solutions have been used.

This renewed interest is just the very tip of the iceberg.

The reasons for stray voltage are both simple and complicated. Its definition is also taking on new meanings: either "traditional" or "fuzzy".

The former refers to problems like loose connections, broken grounding rods, faulty electrical motors and improper wiring.

The gray areas of stray voltage border on the "voodoo" technology. Here's where the situation gets a little hairy, and the correcting the problems a bit expensive. In fact, if some theories the solutions may dictate a radical change in the way we transmit electricity.

At a time when we lack an energy policy in this country, reevaluating electrical transmission system is certainly out of the question.

Stray voltage is not confined to the dairy barns alone, some experts say. It is affecting anyone and any occupation where electricity is a crucial part of life.

If you sleep under an electrical blanket or atop a waterbed, you are exposing yourself to stray voltage as much as smoking a pack or two of cigars.

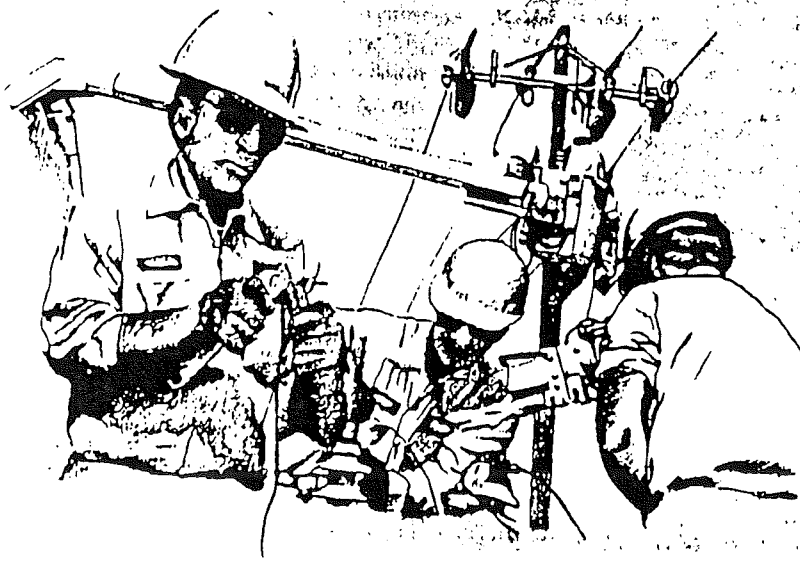
If your home is near the overhead power lines, it could be reassembling a puzzle you never seem to overcome, or for the same deadly disease that has plagued your family and neighbors.

Stray voltage has repeatedly been ignored by electrical engineers, calling it science fiction. In some instances, they dispute the observations and experiences of dairy farmers. Why? Who knows, but you can speculate as to the reasons.

The state of Minnesota has taken the first (albeit overdue) step on this matter. It can't end here.

Issues of the 90's

EMF-cancer link remains unproven



The link between Electric and Magnetic Fields (EMF) and cancer remains unproven, according to a draft Environmental Protection Agency report released in December.

The EPA is asking for public comments on the draft before making the report final.

The draft, which is a review of previous studies, says a connection between EMF and health is in doubt because scientists still don't understand "the basic nature of the interaction" between cancer and electric and magnetic fields.

EPA's report says that although some studies show a statistical link between EMF exposure and cancer, others have failed to confirm those results. Adding to the uncertainty, studies so far have not shown how electric and magnetic fields could interact with cells to affect health.

EMF is present when electricity moves through a wire. The fields surround utility power lines, home wiring, water pipes which return currents to the ground, kitchen appliances, TVs, computers, electric blankets, and heater wires in floors and ceilings. The strength of the fields depends on the current in the wire, and distance from the wire.

The EPA draft report cites studies that have compared childhood cancer and residential EMF exposure, finding "a consistent pattern of response that suggests, but does not prove, a casual link."

So little is known about how EMF affects biological processes that it is "difficult to make quantitative estimates of risk," the EPA report says. In fact, some studies suggest that exposure to higher levels of EMF is actually less hazardous than lower levels.

Governments and electric utilities around the world are currently spending \$15 million a year to research the health effects of EMF.

Basic questions about EMF

Q. What are electric and magnetic fields?

A. Whenever electricity moves through a wire both electric and magnetic fields (EMF) are present. Three things cause exposure to EMF to vary — how close you are to the wire, how much current is flowing through the wire, and the voltage on the wire.

Q. What are the sources of EMF?

A. Because electricity is so common in daily life, most of us are exposed to EMF produced by electric power virtually all the time. Examples of sources include utility power lines, home-wiring, home water pipes (which return currents to the ground), kitchen appliances, TVs, computers, electric blankets, and heater wires in floors and ceilings.

Q. Is exposure to EMF harmful?

A. No one knows for sure. However, because of concerns raised by recent studies there was obvious need for more research and a number of projects have been initiated by the electric utility industry and others. One major report on EMF by the U.S. Congress's Office of Technology Assessment, summarizes present knowledge this way: "In our view, the emerging evidence no longer allows one to categorically assert there are no risks. But it does not provide a basis for asserting that there is a significant risk."

Q. Have any human health risks been discovered?

A. Over the past decade several dozen studies have examined health records, producing contradictory results. The disease that has been a major interest is cancer. Some studies have shown no association between cancer and exposure to EMF, others have suggested a possible weak correlation. A statistical association, for example, has been reported in some studies between measures of exposure to EMF and some forms of cancer in children, as well as among workers in electrical occupations.

Q. How should these contradictory results be interpreted?

A. Interpreting the results of studies requires considering the certainty of the evidence and the magnitude of the risk. So far, there is still a lot of uncertainty because of conflicting results. Possible causes other than EMF have not been ruled out and meaningful measurements of actual exposure to fields have not been made.

The worse case: Two studies have indicated that a child's risk of developing cancer might increase from about 1 in 10,000 to about 2 in 10,000 by living near a major electric distribution line. However, other studies based on a similar kind of study have shown no increases in cancer among children living by power lines. Additional studies are underway.

Q. Are new EMF standards being considered?

A. A few states have set new limits on the maximum fields allowed at the edge of a transmission line right-of-way. New standards related to the fields from distribution lines, appliances, or home wiring have generally not been considered necessary and would in any case, be difficult to set without additional information.

Q. How can EMF exposure to individuals be measured in the home?

A. Determining actual exposure to fields is difficult, since the task involves not only measuring field levels from various sources at different times of day, but also monitoring the time a person spends near each source. The Electric Power Research Institute is sponsoring development of new instruments that should greatly improve monitoring research, and a major study of exposure is now being organized.

Q. What should the government and industry do about EMF?

A. Most important by far is to continue and expand research on EMF to find out whether there is a health risk. In the meantime, there are three basic opinions about what we should do. They are:

Decide there is not enough evidence to justify any action.

Decide there is some basis for concern and adopt policies and operations to minimize risks.

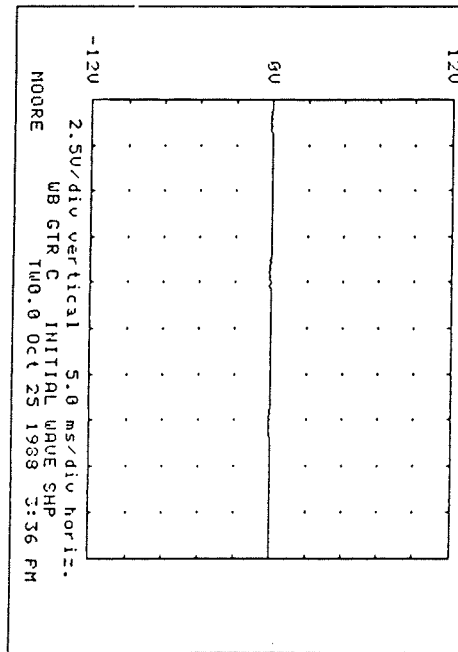
Decide there is a serious problem and adopt an aggressive program of regulation and control.

Obviously, the more we know about EMF, the easier it will be to make the right choice from among those possibilities.

Q. What should I do about EMF?

A. The best thing to do is to keep yourself informed. And stay in touch with your electric cooperative as a source of new information. There simply are no definite answers right now, but by staying informed, we will be able to make the best judgments possible. — *Information prepared by the National Rural Electric Cooperative Association, Washington, D.C.*

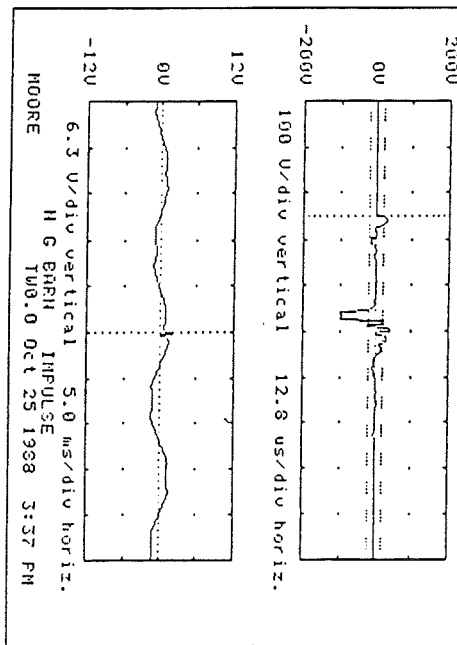
MOORE TWO.0 Oct 25 1988
WB GTR C INITIAL WAVE SHP 3:36:46 PM



BMI

MOORE TWO.0 Oct 25 1988
N G BARN IMPULSE 3:37:20.12PM

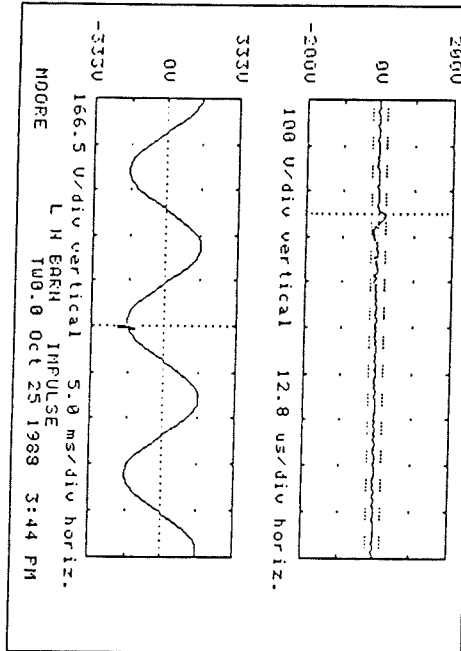
102 U peak
104° phase position
2.5 usec rise time
est. 660 uJoules (50 ohms)



BMI

MOORE TWO.0 Oct 25 1988
L H BARN IMPULSE 3:44:41.65PM

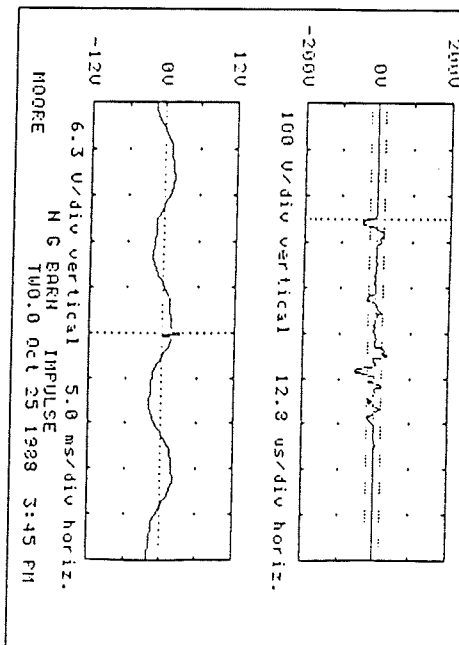
29 U peak
291° Phase Position
3.0 usec rise time
est. 68 uJoules (50 ohms)



BMI

MOORE TWO.0 Oct 25 1988
N G BARN IMPULSE 3:45:12.17PM

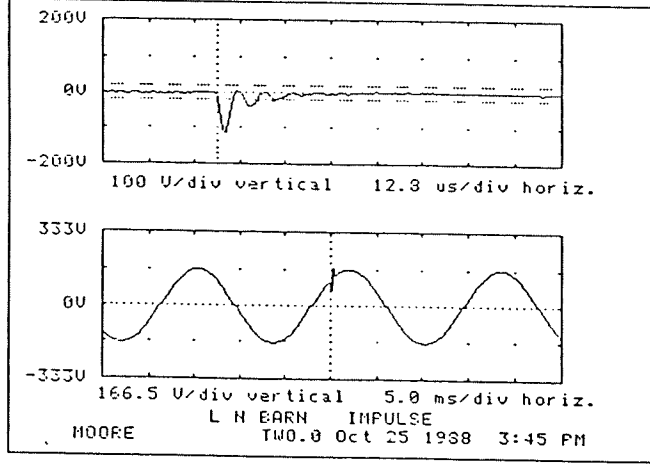
57 U peak
126° Phase Position
3.0 usec rise time
est. 310 uJoules (50 ohms)



BMI

MOORE TMO.U Oct 25 1988
L N BARN IMPULSE 3:45:21.11PM

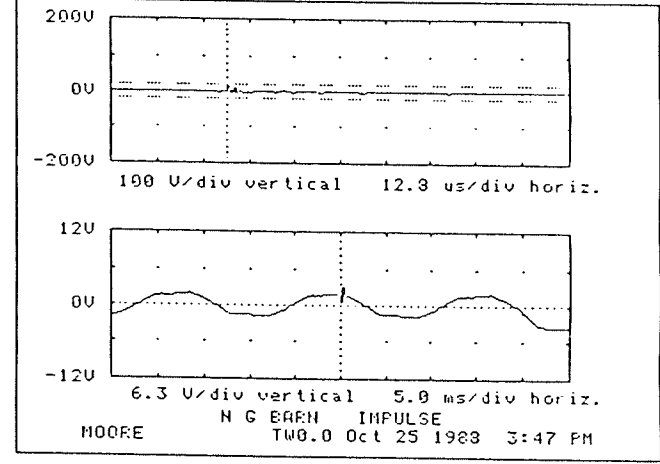
117 U peak
52° phase position
4.0 usec rise time
est. 750 uJoules (50 ohms)



BMI

MOORE TMO.0 Oct 25 1988
N G BARN IMPULSE 3:47:39.78PM

22 U peak
126° phase position
1.0 usec rise time
est. 20 uJoules (50 ohms)



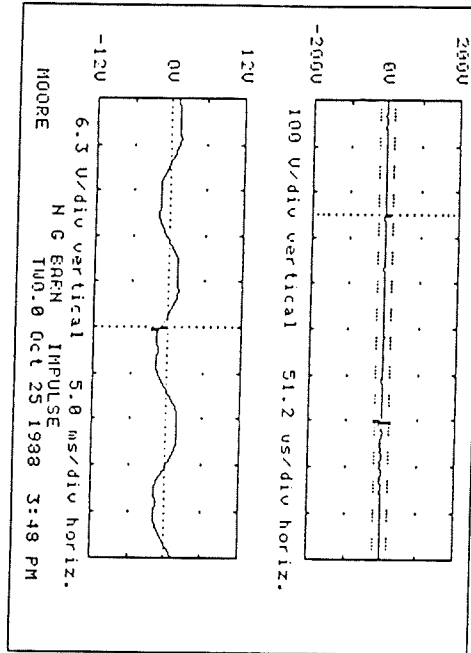
BMI

at 3:47:43 mlt
cooler turned on

N G BARN IMPULSE

3:48:21.13PM

32 U peak
217° Phase Position
4.0 usec rise time
est. 150 uJoules (50 ohms)



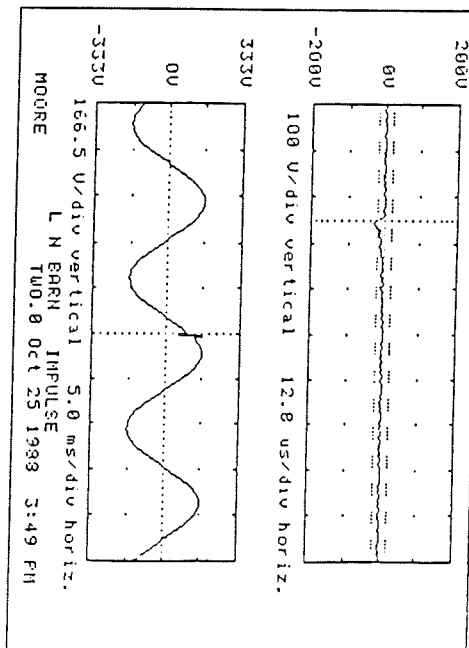
BMI

at 3:48:25
water heater on

MOORE TWO.0 Oct 25 1988

L N BARN IMPULSE 3:49:00.99PM

32 U peak
46° Phase Position
3.0 usec rise time
est. 100 uJoules (50 ohms)

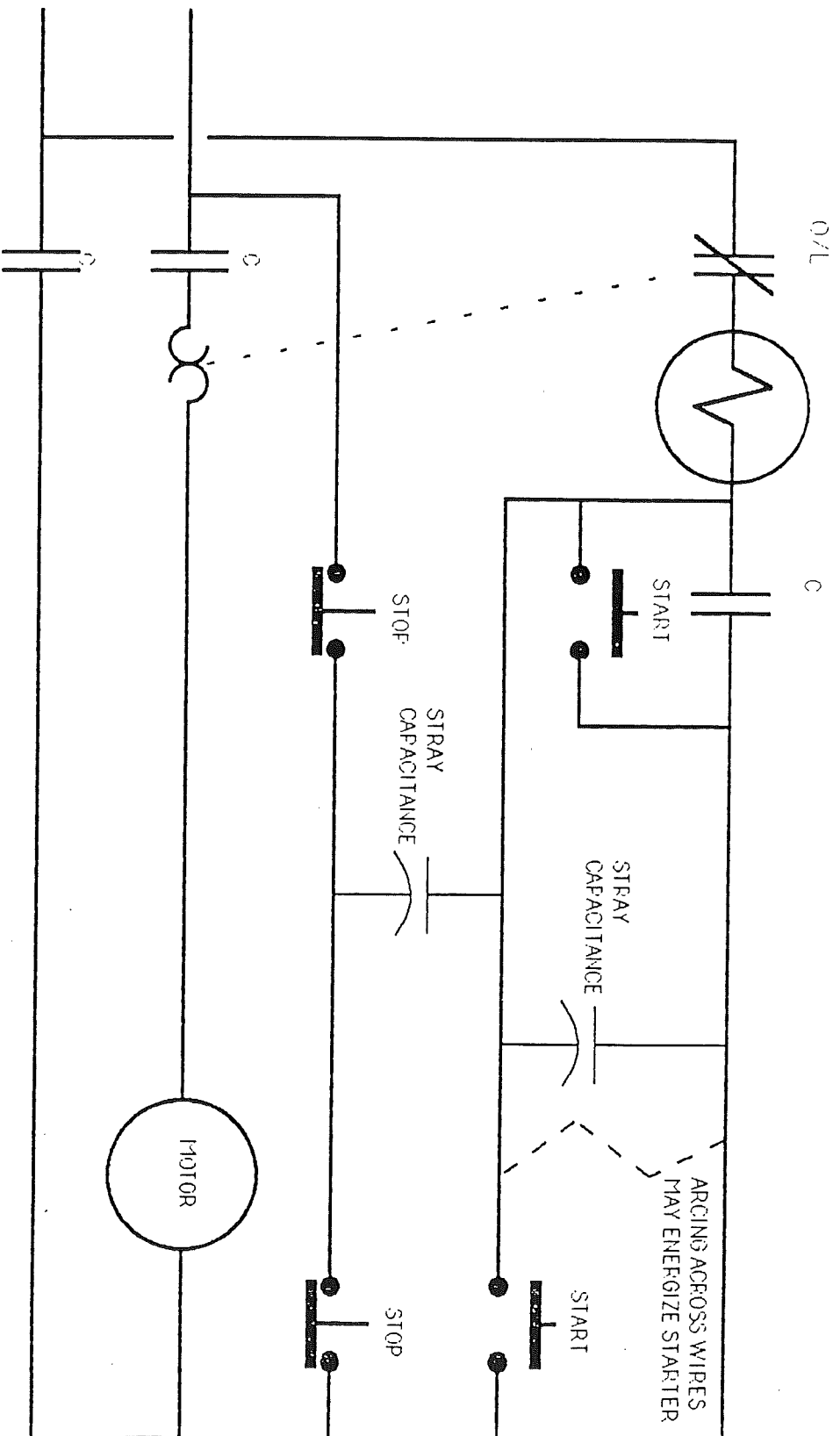


(17 impulses during recovery.)

BMI

at 3:49:08
water heater off

APPENDIX 'N'



APPENDIX 'C'
M

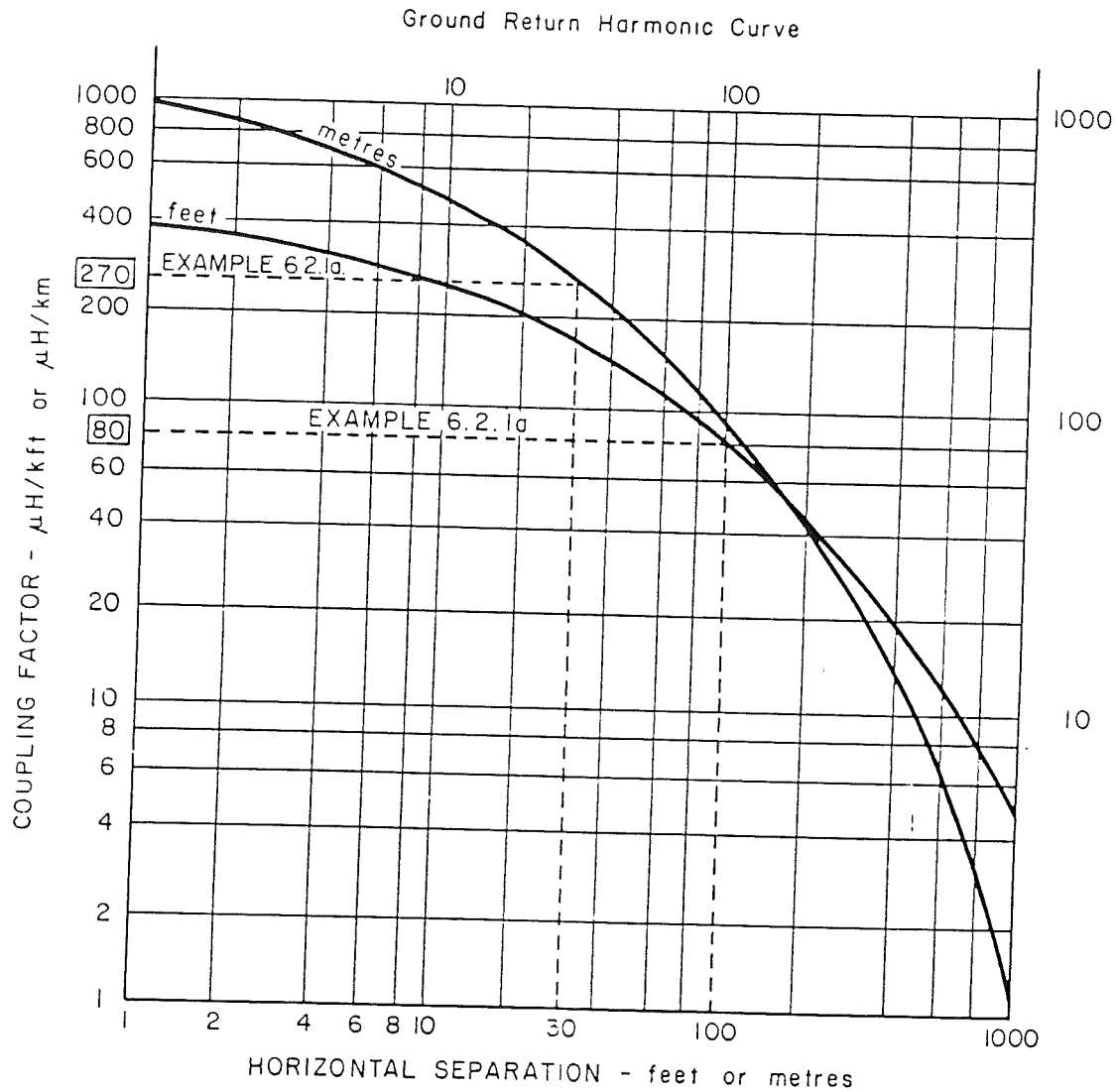
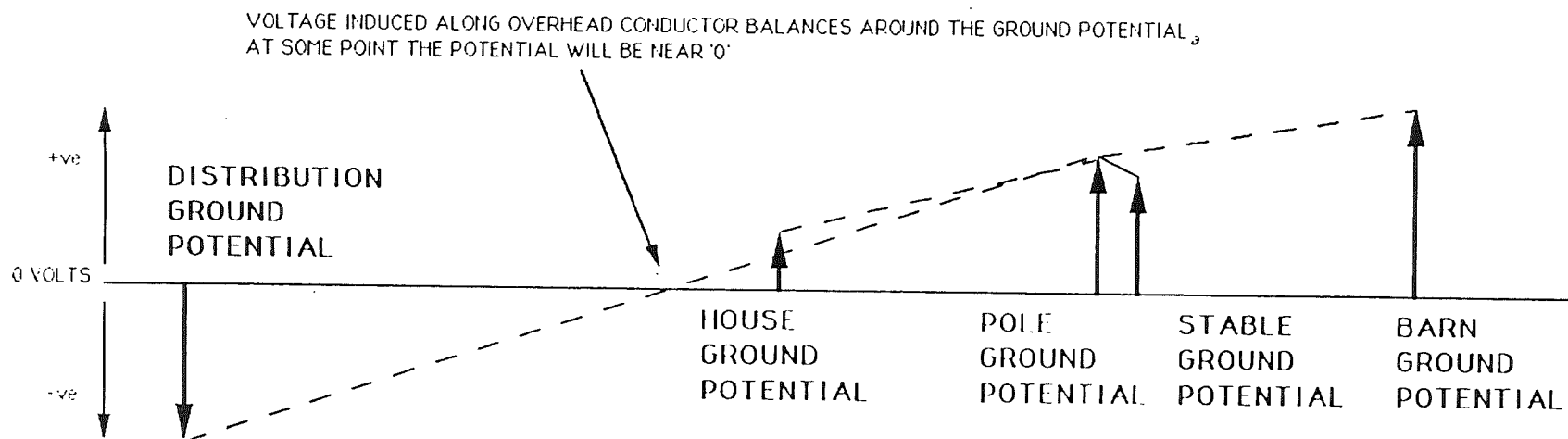
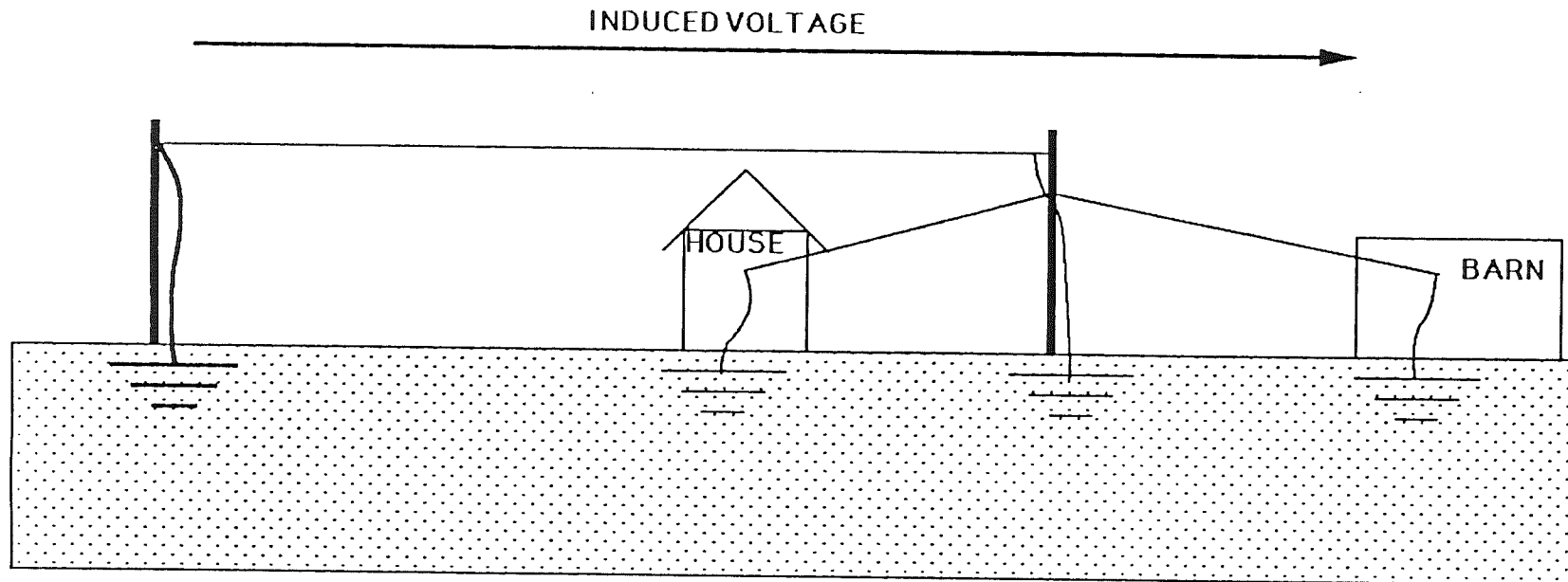


FIGURE 12 - (a)

Graph to obtain coupling factors for longitudinal induction from ground return harmonic current. Not to be used for estimating induced voltages at the fundamental frequency.

FIGURE 12
COUPLING FACTORS FOR LONGITUDINAL INDUCTION
(See Para. 6.2)

APPENDIX 'K1'



We do not recommend the use of fertilizers or pesticides in irrigation systems located alongside transmission lines since these ingredients can increase the water's conductivity. With the aid of a lightbulb and a couple of electrodes immersed in water, the increased conductivity of water when salt, fertilizers, or pesticides are added to water can readily be demonstrated.

14. Explosives

The public is advised not to use electric circuit detonators for blasting operations in the vicinity of transmission lines. Non-electrical detonators are recommended. It is also recommended that whenever blasting is conducted near power lines, the manager of the local Ontario Hydro area office be notified so that the proper safeguards can be taken.

15. Audible Noise

EHV transmission lines can barely be heard in good weather. They are more audible in wet weather yet, even then, the noise level is less than that caused by rain falling on a roof. A demonstration during inclement weather allows the public to experience the worst case situation, but complicates other outside demonstrations. For fair weather visitors, a tape recording is available which, with the aid of a sound level meter, can be adjusted to the proper noise level.

16. Aerial Spray or Dusting Operations

Aerial spray or crop dusting operations from airplane or helicopter have been carried out in the past with very few problems. EHV lines provide better clearances and the conductors are more visible. No special restrictions on these operations are planned.

17. Fires

Large fires should not be started under lines since they could damage the conductors and cause a power outage. It is also remotely possible that the power could flash over to the ground, through the hot air and smoke, creating a hazardous area in the vicinity of the fire.

With the aid of a transmission line model, whose phases are energized at 10 kV, we can show that placing a flame under the conductors can cause flashover phase to phase and even phase to ground.

18. Ozone

EHV transmission lines do not produce harmful amounts of ozone, a naturally-occurring atmospheric gas which is used in air fresheners and water purification. Extensive studies and tests on existing lines have shown that the amount of ozone produced

by transmission facilities is so small, compared to the ambient levels, that it is difficult to measure. By contrast, the action of sunlight on air contaminants around cities produces ozone in very large quantities which, over a prolonged period of time, could be harmful to humans, plants and animals.

With the aid of an ozone meter, it is shown that ozone levels encountered at the demonstration site, which is 80 km (50 mi) and not downwind from any large cities, the levels of ozone are so low that most of the time they barely register on the meter. By taking readings in various locations near and away from lines, it can be shown that the low reading is mainly the natural atmospheric background level of ozone. A home air freshener unit is shown to produce more than enough ozone to drive the meter needle off scale. With the aid of a chart, a comparison is shown between the very low levels that can be produced by the lines, the ambient levels encountered at the site, and the large levels often encountered near or downwind from large cities.

19. X-rays

Transmission lines do not produce x-rays. The x-ray myth has probably arisen as a result of the defective TV set scare of a few years back. At the demonstration centre, we show x-ray film that has been on the phase conductors 2,000,000 times longer than the normal x-ray exposure. The film shows no traces of x-rays as it has remained completely clear. Similarly, the use of radiation dosimeters confirms that there are no x-rays produced.

20. Radio Reception

Using a low-priced AM-FM radio, we show the reception available on both bands. There is practically no effect on FM reception. Being in a valley about 80 km (50 mi) from the nearest FM stations, we use a TV antenna for reception, a common practice with householders in this area. With AM reception, there is no noticeable effect on local or district stations, but weak, distant stations become noisier, particularly during precipitation. This demonstration is performed inside the auditorium which is next to the lines. Also, we demonstrate that citizen band radio units can be operated under or near lines with no noticeable interference.

21. Television Reception

Using a color TV, the quality of reception available from all stations within the normal receiving range is demonstrated. A 12 m (40 ft) mast located at the edge of the right-of-way and a good quality, readily available antenna and rotor are used. This is the closest to the line that any antenna

4. Fluorescent Lamp

The fact that, in daylight, no visible glow can be seen on a fluorescent tube held under transmission line is demonstrated. At night, a faint glow can be seen. This glow is of about the same brightness as when the tube is held near a car ignition, AM radio transmitter, TV set or static generator. It is explained that electric fields excite the phosphorus coating of a fluorescent tube and make it glow. Any field of equal strength will make it glow at the same brightness.

5. Fences

At the demonstration site over 200 m (700 ft) of each of three typical farm fences have been erected under the outside phase of a 500 kV line, where the field is the strongest. On the metal and wood post or on the all-wood post fence no electrostatic charge can be felt as the charge is drained off through the metal, moist wood or contact with earth or grass.

Electromagnetic effects on these fences are also harmless, producing about 1.5 V and 35 ma. This is the same voltage, but much less current than available from a small flashlight battery. Another 45 m (150 ft) by 2 m (7 ft) high chain link fence is completely insulated from ground. Touching a blade of grass or connecting the fence to a single wood or metal post drains off most of the electrostatic charge built up on the fence wire.

6. Electric Fences

Electric cattle fences, being specially insulated from ground, can pick up an induced charge from EHV lines. However, that voltage will be only a small portion of that produced by the charger unit. Usually, the induced voltage will drain off when the charger unit is connected to the fence. When the charger is not connected, the voltage can be drained off by shorting out one of the fence insulators. Where required, Ontario Hydro will provide a filter to reduce the induced voltages caused by transmission lines.

People are warned that only Canadian Standards Association approved charger units should be used on electric fences, as there are other potentially hazardous units on the market in other countries.

It is pointed out that it is dangerous to connect 115-volt household service to an electric fence, either directly from an outlet or through a lightbulb. Even a lightbulb can pass enough current to kill a number of persons at the same time.

7. Refuelling

Although there have been no reported instances of fires caused by a static spark

induced by transmission lines, the refuelling of vehicles under lines could pose a problem in the unlikely event that a number of conditions existed simultaneously (for example, hot, still weather, hot metal surfaces, proper gas vapour to air mixture and a well-insulated vehicle and a grounded refuelling system).

Therefore, it is recommended that refuelling of vehicles or equipment not be carried out within 15 m (50 ft) of a 500 kV line. If there is no alternative, refuelling can be done safely using a plastic gasoline container or by connecting the metal fuel can to the vehicle with a wire to eliminate any possibility of a spark occurring.

An attempt is made to ignite gasoline in a small open top metal container (with cover) which is connected to a large trailer insulated from ground to build up a charge. A spark is drawn inside the container using a grounded metal nozzle. On hot days with the trailer perfectly insulated, it is occasionally possible to ignite the gasoline, but not on cold days or when the tires touch the bare ground.

8. Buildings

Charges will not usually build up on metal-covered buildings since they are normally grounded through their plumbing, electrical service, metal sheeting or frame's contact with earth. No noticeable charges caused by transmission lines will occur inside a grounded metal building.

Small, transmission line induced charges can occur inside a non-metallic farm building, such as a tobacco kiln, if it is situated adjacent to an EHV line. These charges are much less than those created by the air circulating systems in kilns. Coverings, such as chicken wire or metal sheeting, will reduce any electric fields caused by transmission lines but will not eliminate those created by the air circulation. An electric field strength meter is used to show the effectiveness of various materials in reducing the field and thus the induced charges.

The public is informed that Ontario Hydro will provide additional grounding for buildings close to lines, should unusual conditions warrant it.

9. Vehicles

It is demonstrated and explained that vehicles do not normally build up electrical charges when in the vicinity of transmission lines because their tires contain carbon black which makes the tires conducting. A 10 kV furnace transformer is used to show by electrical sparking how conductive tires really are. By placing one car on plastic and another on regular ground the differences

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APPENDIX 'J'

DEMONSTRATIONS TO PUBLIC OF EHV TRANSMISSION LINE EFFECTS

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SUMMARY

Attempts to accurately communicate the effects encountered under or near EHV transmission lines has been a problem leading to various public misconceptions or exaggerations. In response to this problem, Ontario Hydro has set up a public demonstration site under operating 500 kV lines to show the electrostatic, electromagnetic and corona effects on vehicles, buildings, fencing, personnel, livestock, plants and radio and television reception. The opportunity to personally experience these effects has laid to rest many public concerns and resulted in favourable media coverage.

INTRODUCTION

When a 500 kV EHV transmission line grid was proposed which traversed the largely agricultural part of Southern Ontario, public concern was expressed about the electrical effects of these lines. Assurances and explanations at public meetings did not always put fears to rest.

Ontario Hydro has set up a demonstration site under operating 500 kV transmission lines to allow public groups to experience for themselves the electrical effects encountered on a first hand basis. Actual lines are used to dispel doubts that a laboratory type demonstration might give rise to. At the site an auditorium seating 50 persons is available for indoor demonstration and inclement weather use. This is not a drop-in centre. Each program is tailored to suit the time available and interests of the group.

Over 30 different demonstrations are available to show the various electrostatic, electromagnetic and corona effects.

PUBLIC DEMONSTRATION AIMS

These demonstrations are intended to show both the normal and worst case conditions encountered under or near transmission lines. Since the normal situation in many cases produces no noticeable effects and since rumors and tales

are usually based on misconceptions of unusual or extreme conditions, props or intensifiers are sometimes used to show the worst cases that might be encountered. A person, having seen the worst case will not be as concerned about an electrical effect, should he encounter it. If he was experiencing it for the first time not knowing what it was, it would certainly seem more menacing. In most instances, even the worst-case demonstrations are only annoyances and not hazards as might be assumed by an inexperienced person.

For the public presentations, most of the technical terms have been eliminated from the presentation, reliance on and use of meters has been reduced to a minimum, and in place of actual figures, comparisons with familiar situations are used. The style of the demonstration is "see and touch", making the presentation easy to follow for persons without a technical background.

TESTING OF PROGRAM

In the fall of 1975, the program was tested, to evaluate and optimize the presentation, at 20 preview demonstrations for representatives of various Divisions and Departments of Ontario Hydro, internal and external study and advisory groups and other utilities in Canada and United States.

Each group was asked to comment on what additions or changes they would like to see to the program. The comments, wherever practical, were incorporated in subsequent presentations.

DEMONSTRATIONS TO TECHNICAL GROUPS

As a result of the early test demonstrations, it became apparent that a second, more detailed and technical presentation was required for training staff involved in the public participation program for route selection and employees who are in regular contact with the public. The technical presentations cover the same material as the public demonstrations with some parts of the program condensed and others expanded with more detail and technical information. Most of the technical training was completed in the late fall of 1975.

PUBLIC DEMONSTRATIONS

In June of 1976, the centre was opened to the public, starting with a presentation to a media group composed of reporters from about two dozen newspapers and three television stations from the cities and towns along proposed EHV line routes.

Overcurrent protection should be applied to transformers as the primary protection where a differential scheme cannot be justified or as "backup" protection if differential is used. Frequently faster relaying may be obtained for power flow from one direction by the use of power-directional relays.

Transformer overheating protection is sometimes provided to give an indication of overtemperature, rarely to trip automatically. Overload relays of the replica type may be connected in the current-transformer circuits to detect overloading of the unit. Others operate on top-oil temperature, and still others operate on top-oil temperature supply.

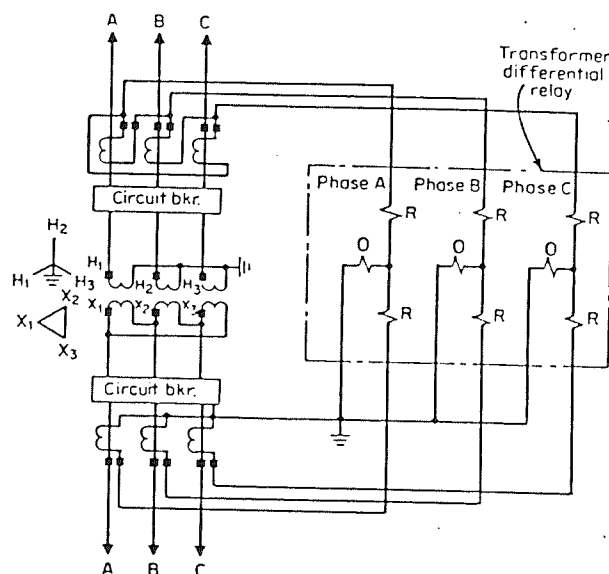


Fig. 17-19. Transformer differential protection for a Y-delta transformer.

mented with heat from an adjacent resistor connected to a current transformer in the circuit. This latter relay is adjusted to operate on a simulated "winding-hot-spot temperature."

Gas- or oil-pressure relays are available for attachment to the top or side of transformer tanks to indicate winding faults which produce gas or sudden pressure waves in the oil. Rapid collection of gas or pressure waves in the oil, due to short circuits in the winding, will produce fast operation. This type of protection is gaining in popularity in the United States.

36. Circuit-Breaker Protection. In recent years great emphasis has been placed on the need to provide backup protection in the event of failure of a circuit breaker to clear a fault following receipt of a trip command from protective relays. For any fault the protective relays operate to trip the necessary circuit breakers. In addition, these same protective relays, together with breaker-failure fault detector relays, will energize a timer to start the breaker-failure backup scheme. If any breaker fails to clear the fault, the protective relays will remain picked up, permitting the timer to time out and trip the necessary other breakers to clear the fault.

Circuit-breaker failure can be caused by loss of dc trip supply, blown trip fuses, trip coil failure, failure of breaker trip linkages, or failure of the breaker current-interrupting mechanism. The two basic types of failures are (1) mechanical failure or (2) electrical failure of the breaker to clear the fault.

Mechanical failure occurs when the breaker does not move following receipt of a trip command because of loss of dc trip supply, trip coil failure, or trip linkage failure.

Electrical failure occurs when the breaker moves in an attempt to clear a fault upon receipt of the trip command but fails to break the fault current because of misoperation of the current interrupter itself.

In order to clear faults for these two types of breaker failure, two different schemes of protection can be employed. The more conventional breaker-failure schemes consist of using instantaneous current-operated fault detectors which pick up to start a timer when fault relays operate. If the breaker fails to operate to clear the fault, the timer times out and trips necessary breakers to clear the fault. However, if the breaker operates correctly to

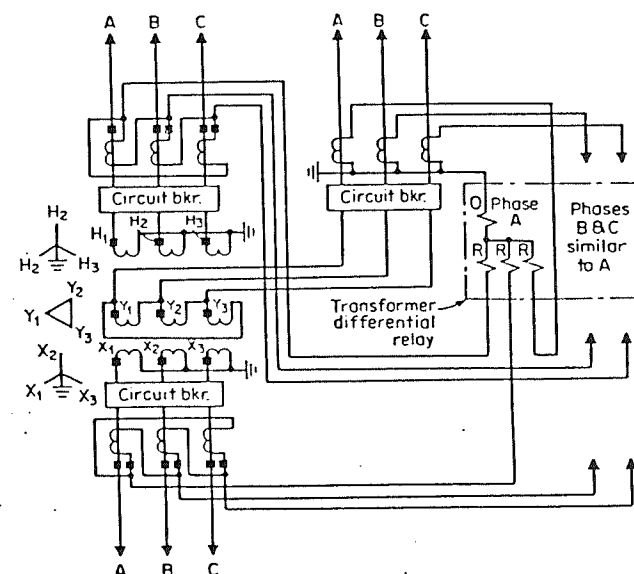


Fig. 17-20. Transformer differential protection for a Y-delta-Y transformer.

clear the fault, enough time must be allowed in the timer setting to ensure reset of the fault detector relay. Total clearing times at EHV using this scheme are quite fast and usually take 10 to 12 cycles from the time of fault until the fault is cleared.

For those faults where mechanical failure of the breakers occurs, an even faster scheme is in use. This scheme depends on a breaker auxiliary switch (normally open type 52-A contact) to initiate a fast timer. The auxiliary switch is specially located to operate from breaker trip linkages to sense actual movement of the breaker mechanism. If the breaker failure is mechanical, the breaker-failure timer is actuated through the auxiliary switch when the protective relays operate. The advantage of using the auxiliary switch is the extremely fast reset time of the breaker-failure timer that can be realized when the breaker operates correctly. Schemes in use with the fast breaker-failure circuit can attain total clearing times of 7.5 cycles when a breaker failure occurs.

37. Shielding and Grounding Practices for Control Cables. For several years the increased application of solid-state devices for protective relaying and control and for electronic equipment such as audio tones, carrier and microwave equipment, event recorders, supervisory control equipment, etc., in EHV substations has resulted in many equipment failures. Many of these failures have been attributed to transients or surges in the control circuits connected to the solid-state devices. Failures due to transients or surges have been experienced even with conventional electromechanical devices.

The failures being experienced are attributed to the use of EHV (345 kV and higher voltage levels) as well as the presence of unusually high short-circuit currents. One of the major sources of transient voltages is the switching of capacitance, for example, the

*A Chronological Survey of
Stray Voltage Publications and
Documentation as Compiled by
The Electromagnetic Research
Foundation (TERF)*

1980-1994

New Study Strengthens Suspected Links Between Electromagnetism and Cancer

By BILL RICHARDS

Staff Reporter of THE WALL STREET JOURNAL

After nearly a decade of uncertainty, scientists are beginning to sound warnings that low-frequency electromagnetic fields—generated unseen and unfelt by everything from power lines to pop-up toasters—may pose a broad new cancer risk.

New York state health authorities last week unveiled a study that appears to link exposure to electromagnetic fields with leukemia and other cancers in children. "If the results are correct," says David Carpenter, a New York health official who headed the study, "as many as 10% to 15% of the cases of childhood cancer may result from residential electromagnetic field exposure." About one child in 10,000 in the U.S. has cancer.

Scientists say New York's study requires additional scientific corroboration, but is the most solid evidence to date that some sort of connection exists between electromagnetism and cancer. At least nine scientific studies published since 1985 have raised that possibility, although critics say most are scientifically flawed.

'A Reasonable Premise'

"We have taken what was seen as a flaky fringe idea and raised it to a reasonable scientific premise," said David Savitz, an epidemiologist at the University of North Carolina's school of public health and one of the three researchers who conducted the New York study.

New York's findings already have utility experts and others scrambling for additional research. If the study's findings hold up, the utility industry could face "multiples of billions of dollars" in regulatory and legal costs, says Leonard Sagan, program manager for radiation studies at the Electric Power Research Institute, a utility-funded research group in Palo Alto, Calif. Dr. Sagan calls the research to date on the effects of electromagnetism "fragmentary and inconsistent" and says some studies haven't found any apparent relationship between magnetic fields and cancer. But he says the institute is spending \$2.5 million to study the subject this year and will step up its spending next year.

Some state officials aren't waiting for more research. New York's Dr. Carpenter, who heads the School of Public Health Sciences at the State University of New York at Albany, says the state's findings "are sufficiently worrisome that we should begin to change the way we wire our homes and not delay for another five to 10 years for additional epidemiological studies."

Officials in Florida recently began drawing up regulations to limit the amount of electromagnetism that new power lines may generate. Six states already limit the

intensity of electrical fields around power lines, but Florida would be the first to restrict magnetism around its lines.

"We didn't have a standard, and it appears from recent research that magnetic fields may be causing biologic or health effects," says Hamilton S. Owen Jr., siting coordination administrator for the state's environmental regulation department.

Florida's proposed standard limits the strength of electromagnetic fields at the edge of new power-line rights-of-way to between 30 and 500 milligauss. The final standard would be set after public hearings. A

THE FINDINGS of a new study 'are sufficiently worrisome that we should begin to change the way we wire our homes,' says one health official.

gauss, named for the 19th century physicist, is a measure of the intensity of a magnetic field. Physicists estimate that the electromagnetic field 200 meters from a high-voltage line would register about 10 milligauss, the strength of such a field in an average home.

In California and Florida, utilities are facing lawsuits from school districts fearful of potentially harmful health effects from proposed high-voltage power lines. And in Texas, Houston Lighting & Power Co. is appealing \$25 million in punitive damages awarded by a Houston jury to the Klein Independent School District. District officials filed suit after the utility strung a 345,000-volt line next to a school complex with 6,500 students.

"People were concerned there were unanswered health questions about that line," says Donald Collins, Klein's superintendent. "They didn't want their children to be subjected to an experiment."

A spokesman for the Houston utility says the high-voltage line has been closed down and is being rerouted away from the school complex. "We still feel the body of scientific research doesn't support the jury's finding," the spokesman says.

Power lines generate both electric and magnetic fields, reflecting the voltage or thrust of electricity through wires and the actual amount of current in the wires. Until the late 1970s, researchers concentrated most of their efforts on the effects of electric fields around high-voltage power lines, often relying on fragmentary anecdotal evidence such as reports from farmers that cows near high-voltage lines seemed to give less milk.

But in 1979 two University of Colorado researchers examined 491 homes in the Denver area where youngsters had died of cancer. The study showed that an unusual number of deaths occurred in homes near secondary power lines, and the two scientists concluded that long-term low-level electromagnetic fields from the street lines seemed to be related to the cancer incidence.

Critics poked a number of holes in the study, but it triggered other efforts to match magnetic fields and cancer. Some recent studies, for example, show unusually high levels of cancer among workers with heavy exposure to electromagnetism, such as electricians, utility workers and motion-picture projectionists.

Looking for a Link

New York's Dr. Carpenter says the state decided to launch its investigation after a controversy erupted over the construction of a high-voltage power line near Syracuse in the late 1970s. The state hired Mr. Savitz and two University of Colorado professors to study electric and magnetic fields in 123 Denver-area homes where cancer cases were reported in children. Their three-year study plugged the methodological holes in the earlier Wertheimer-Leeper study and found as much as a threefold higher incidence of child cancer in houses with the highest electromagnetic fields.

Still, Mr. Savitz says the researchers haven't been able to establish electromagnetism as a cause of cancer. "We don't know if there's a cause-and-effect relationship," he says. "There's a strong justification for concern, but we clearly can't document the hazard like you can for asbestos or cigarette smoking."

Medical investigators are rushing to plug that gap. One San Antonio, Texas, research team has reported finding that exposure to electric and magnetic fields increases the growth of cancer cells and their resistance to destruction. Other teams are studying how magnetic fields apparently trigger cancer growth. Certain intensities of magnetic fields apparently prompt abnormal movements of calcium into cells, which in turn appear to activate a calcium-dependent enzyme.

"The speculation is that the enzyme may be changing the activity of key cellular oncogenes—genes involved in regulating cell growth and associated with cancer," says Jerry Phillips, director of biomedical research at the Cancer Therapy and Research Center in San Antonio.

Dr. Phillips says the techniques are available to merge various scientific theories and determine whether electromagnetism and cancer are linked. "We could have some important answers within five years," he says.

MICROWAVES VERSUS HOPE

The Struggle at Greenham Common

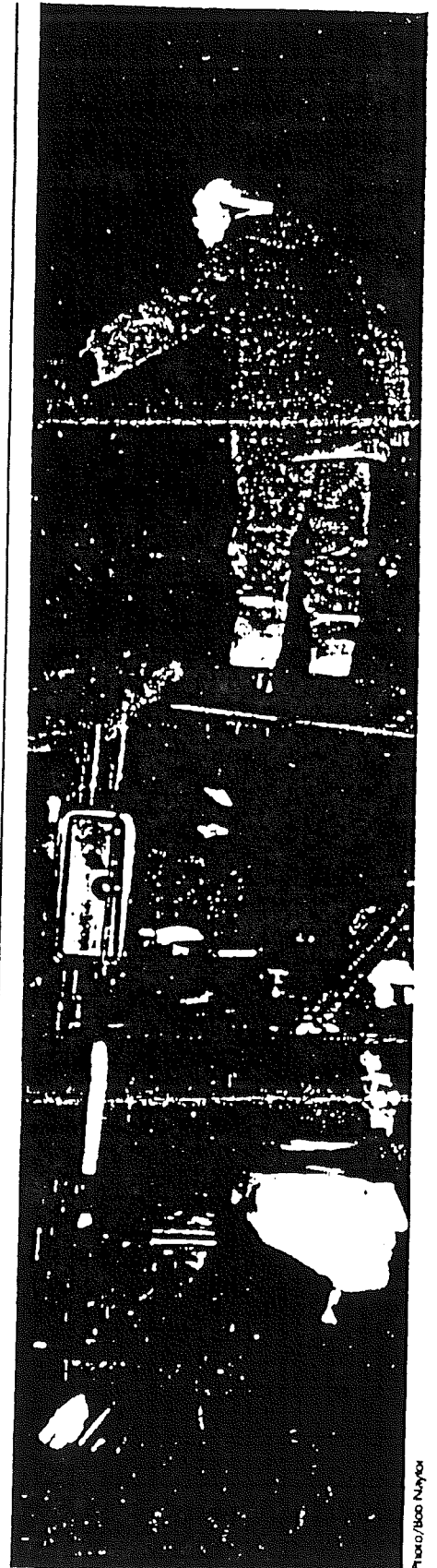
BY JOSEPH REGNA

On the Caribbean island of Guadeloupe in January 1979, U.S. President Jimmy Carter met with the heads of state of West Germany, France, and Britain and secretly agreed to install a so-called new generation of nuclear weapons in several Western European countries. In December 1979, NATO ministers formally agreed to deploy 108 Pershing IIs and 464 ground-launched cruise missiles—known as the Euromissiles—beginning in late 1983.

One of the destinations of the cruise missiles is also the site of the longest continuous protest presence against nuclear weapons buildup: the U.S. Air Force Base at Greenham Common, located in the British countryside 60 miles from London. The base is bounded by a nine-mile perimeter fence, broken only by gates named by color. Since September 1981, women have maintained peace camps at these gates, most notably and visibly at Green Gate.

Once the missiles themselves started arriving three years ago, an escalation and shift in protest activity ensued. The reason lies in the very nature of cruise missiles: their mobility. A cruise missile is small enough so that it can be mounted on the back of a truck—called a launcher vehicle—and driven to some predetermined launch point.

In preparation for nuclear war, the U.S. military at Greenham Common has engaged in about 30 "dispersal exercises" since March 1984. During an exercise, a convoy of cruise missiles leaves the base in



Photo/Boo Naylor

Wisconsin State Journal 1/14/91

Radiation worries politicians

By Jeff Meyers

State government reporter

Legislators' biennial office shuffle is being complicated for once by a force that has nothing to do with partisan politics or politicians' egos — electromagnetic radiation.

Although the effects of the widespread phenomenon on human health are uncertain, legislators and workers in the DiVall Building, 100 N. Hamilton St., just off the Capitol Square, are worried enough to bring it to the level of an administrative problem.

"I think there is some level of concern here," said Katie McGrath, an aide to state Rep. Thomas Seery, the Milwaukee Democrat appointed by Assembly Speaker Walter Kunicki, D-Milwaukee, to look into the situation. "There isn't a panic going on."

"Some concern has been expressed," said Administration Secretary James Klausner, whose department oversees state office space. "I can't say that it is" a safety problem.

Gary DiVall, owner of the building, said it's the problem of Madison Gas & Electric Co. and said he, state and utility officials are to meet within the next couple of weeks to discuss a private consultant's report ordered by DiVall. The state is withholding rent on three rooms in the building because of the problem.

An MGE spokesman, Steve Kraus, said levels have been reduced since the controversy arose during the summer and the utility "thought it was pretty well over with."

But the office shuffle has renewed the controversy.

McGrath said some legislators and their staffs don't want to move into the building, and some of those who are there don't want to move within the building to offices where higher readings of electromagnetic radiation have been recorded.

Seery's office asked UW-Madison scientists to investigate, and because there hasn't been a response Seery now has the go-ahead to bring in a private consultant to study electromagnetic radiation levels inside the building, she added.

There have been conflicting reports and conclusions from scientists about whether electromagnetic fields from power lines, appliances, electrical wires and a variety of other common items could cause cancer. One UW-Madison expert, Dr. F. Kristian

Storm, chairman of the surgical oncology department, has said research shows "no substantial risk of cancer from electromagnetic radiation." But still, people worry.

"People in the building are waiting," McGrath said Friday. "They want to know one way or another."

The DiVall Building is being rented by the state for about \$528,000 a year while the Capitol is being renovated, according to the Department of Administration, which has received informal inquiries about finding alternative rental space in Madison. The building has been temporary home for about a year to the Legislative Reference Bureau and legislators and staff from the Capitol's north wing.

"People are freaking over there," said one top Democratic

legislator, who called the rental choice a mistake. "They want out."

The electromagnetic radiation flap started when workers noticed problems with computers situated above a transformer vault in the basement of the DiVall Building. MG&E found electromagnetic radiation levels in hundreds of milligauss, said MG&E spokesman Kraus. After wires leading to and from the vault were rearranged last summer to cut down the magnetic field, he said, average readings were less than 50 milligauss.

"There are no federal or state standards," he said. "We have no information from any scientific arena that these levels, or levels

much higher, are dangerous."

Since summer, several rooms at the Legislative Reference Bureau have been used only part-time because of the problem, legislative officials report. And rent has been withheld on three rooms in the building, said Donald Schneider, the Senate clerk, who suggests the transformer vault be relocated outside of the building.

"We need the rooms," he said.

Senate President Fred Risser, D-Madison, who's on the state Building Commission, said there have been other problems at the DiVall Building, including air conditioning.

"If the problems are serious enough, this ... would be a breach of rental agreement, and the state could act accordingly," Risser warned. "I don't think we've reached that point yet. There's ongoing negotiations between the state and DiVall on these problems."

DiVall said to his knowledge, the air conditioning problems were fixed. As for the electromagnetic radiation, he said: "These electromagnetic fields are in almost every building. Of course, nobody wants to admit that."

EMF task force backs partnership

Research into the health effects of electromagnetic fields should be expanded through a partnership funded half by the federal government and half by nonfederal contributions, APPA's EMF Task Force recommended Jan. 22.

In a draft resolution, the task force noted that increasing public concern about EMF has put pressure on state legislatures, utility commissions, and Congress to take action to reduce perceived risks. While some scientific studies have suggested a link between exposure to EMF and cancer or other adverse effects, others have found no such association. An aggressive research program is needed to lay a sound founda-

(continued on page 3)

(continued from page 1)

tion for decisionmaking on the issue, the panel concluded.

Current research by the federal government and the Electric Power Research Institute must be maintained, but should be supplemented by substantial investigation paid for by federal and private funds, the task force said. The panel recommended an aggressive congressional campaign to secure more federal monies for EMF research, implementation of a federal-private study program administered by an independent, reputable research institution, a beefed-up effort to collect and disseminate information on EMF to APPA members, and the preparation of materials to help public power systems educate their customers and employees about the issue.

The concept of an expanded EMF research effort jointly funded by a federal-nonfederal partnership, originally conceived by the Large Public Power Council, was formally backed Jan. 10 by the Edison Electric Institute. (See *Public Power Weekly*, Jan. 21, 1991, page 1.) The LPPC suggested a \$30 million national program administered by the Health Effects Institute in Cambridge, Mass.

The draft resolution will be presented to APPA's Legislative and Resolutions Committee in March and, if adopted, will serve as interim policy for the association until APPA's annual conference in June. If adopted at the conference, it will become APPA policy. ■

Major Study Indicates Electric Wires May Boost Risk of Childhood Leukemia

By FREDERICK ROSE

Staff Reporter of THE WALL STREET JOURNAL

Preliminary results of a major new study has added evidence that proximity to electric transmission wires may increase the risk of childhood leukemia.

Early findings of the study by John Peters and associates at the University of Southern California suggest that, among a sample of 464 children in the Los Angeles area, those living near defined clusterings of power lines and equipment were about 2.5 times more likely to have leukemia.

The study, though still subject to scrutiny by other scientists, appears to support growing research in which ties were found between electrical equipment, with their electro-magnetic fields, and cancer risks.

Recently, a federal Environmental Protection Agency report said that fields from electric power lines are a possible—if not proven—cause of cancer. And studies in the Denver area noted correlations between childhood cancer and neighboring power lines.

Body of Evidence

Dr. Peters' work "adds to the body of evidence" that some still-unexplained process may be increasing the risk of cancer, said George Hidy, who heads the environment division of the Electric Power Research Institute, an industry-financed group that paid for the study.

The cancer risks found by the study remain relatively low. The overall frequency of childhood leukemia is about one case for every 20,000 children. An increase of 2.5 times in this frequency implies 2.5 cases for every 20,000 children.

In one sense, the latest research adds to the mystery of electro-magnetic fields and cancer. While it found leukemia more likely among children near strong power lines and equipment, it failed to find any

significant correlation between the measured strength of magnetic fields given off by those lines and the likelihood of leukemia. That was a key question that researchers had hoped to answer.

Sketchy Conclusions

Results of the University of Southern California research were discussed yesterday at a scientific conference in Carmel, Calif. Sketchy conclusions were disclosed in both an "executive summary" written by Dr. Peters and in material prepared by the Electric Power Research Institute. However, Dr. Peters couldn't be reached for comment and has indicated that he won't discuss results of the study outside scientific circles until they have received "peer review" by fellow scientists and have been published.

In his executive summary, Dr. Peters noted "considerable" evidence of a relationship between children's use of electric appliances and the risk of leukemia.

According to the Electric Power Research Institute, the appliances found to have strong correlations were hair-dryers and black-and-white televisions. The industry research group questioned these particular findings, saying that they depended on parents' memories of appliance use and thus were less objective than other elements of Dr. Peters' findings.

The results of the study have been widely awaited because of a large sample size—some 232 children with leukemia and an equal number of healthy children—as well as intricate readings of electrical and magnetic fields that were part of the experimental design.

"The study opens up new ground and shows that we need to do more research work," said a spokeswoman for the Edison Electric Institute, an association of electric utilities.

February 12, 1991
WUA (Revised)

PUBLIC SERVICE COMMISSION OF WISCONSIN

DOCKET #05-EI-108

Reports of problems on farms that have no measurable "stray voltage" has raised the question of the possible effects of other electrical phenomenon. When the Commission was considering its recent limited reopening of docket 05-EI-106 on isolation tariff issues, a petition was received to also expand the reopening to cover the issues of direct current, ground current and EMF effects. The Commission denied that petition but opened docket 05-EI-108 for the purpose of reviewing knowledge and research regarding direct currents, ground currents and EMF and their potential effects on livestock especially dairy cows.

Potential EMF effects on humans and farm animals are two different concerns which have been identified by the Commission. The Commission has indicated that it will continue to investigate the basic questions of human health concerns in its Advance Plan process. The issue of EMF and its potential effects on confined livestock and the dairy industry will be examined in this docket.

The Wisconsin Utilities Association members recommend that seven possible phases be considered in this docket. They are listed below for discussion purposes:

PHASE 0: Perform various measurements on an inactive dairy farm that is still equipped with facilities to simulate an active farm i.e. run vacuum pump with water in pipeline, etc. A variety of meters will be evaluated as far as appropriateness and necessity for future farm investigations. Calibration of the meters should be done prior to bringing to the farm. Following the on farm testing, a review will be done to determine which meters are best suited for each type of measurement needed.

PHASE 1: Evaluate two farms with the objective of developing an appropriate measurement protocol. This protocol must include definition of all parameters being assessed, identification of appropriate instrumentation and procedural guidelines for performing measurements and recording results. Therefore, the first phase of an extended research initiative must accomplish these objectives so a refined measurement process can be considered for future farm investigations.

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Page 2

- PHASE 2: Review the work performed in phase one. Develop a written plan for phase three including definition of all parameters being assessed, instrumentation, specific measurement procedures, criteria for selection of farms, number of farms, estimated costs, method of financing, etc. and attain necessary approvals and financing to implement.
- PHASE 3: Measurements and data collection on an expanded number of farms.
- PHASE 4: A complete review of measurements and data gathered in phase three to determine any correlations between animal health/performance/behavior and the measured parameters.
- PHASE 5: If it is determined in phase four that there is a correlation between animal health/performance/behavior and the measured parameters then an evaluation of the correlation between the measured parameters and the utility and the farm electrical system configuration should be conducted.
- PHASE 6: Based on correlations found in phase five between the measured parameters and the electrical system configuration a further study may be warranted.

PP/do
0212D-PP.2

PHASE 1: PROPOSAL FOR DEVELOPING AN ELECTRICAL MEASUREMENT
PROTOCOL FOR TWO PILOT FARMS

The WUA Ad-Hoc Committee on PSCW Docket #05-EI-108 believes that the following proposed measurement protocol would provide data that would allow a meaningful analysis of the effects, if any, of EMF, DC, and ground currents on livestock.

This proposed protocol relies upon an important premise: in order for the energies associated with the electrical phenomena under investigation to have an effect on livestock health, these energies must be quantifiable within the animals' environment. Regardless of the specific measurement protocol ultimately decided upon by the PSCW, the Committee urges that this premise be maintained.

WHAT SHOULD BE MEASURED

In order to comply with the intent of PSCW's Docket #05-EI-108, it is felt that several parameters could be meaningfully measured. It should be noted that an attempt to quantify, through direct measurement, the exact amount of ground current* that flows in a specific portion of the earth has not been included. It is common knowledge that manmade and naturally occurring earth currents do exist, and that in the vicinity of an operating electrical system a significant portion of these currents are 60 Hz AC earth-return currents. The Committee feels that since it is the potential adverse effect on dairy livestock that is being investigated it is more important and more meaningful to measure the following resultants of ground currents: 1) electric and magnetic fields associated with these currents as they manifest themselves in the animals' environment, and 2) the amount of current that would physically leave the earth, pass through the animal, and return directly to the earth under various conditions.

The following measurements are recommended.

1. Magnetic Field:
 - a. DC
 - b. 60 Hz
 - c. 0 - 900 Hz
2. Electric Field:
 - a. 60 Hz *AM - FM*
 - b. ~~0~~ (0 - 108 MHz)

* Ground current as referenced in this document refers to electrical currents, natural and manmade, that physically flow in the earth.

Electrical Measurement Protocol for Two Pilot Farms cont.

3. Stray Voltage

Present SVAT procedures are acceptable. For this research, however, existing SVAT techniques should be expanded to include an analysis of dc, transients and harmonic components.

4. Environmental Factors:

Environmental factors that could be measured include items such as water conductivity, water PH, water consumption, temperature, humidity, barometric pressure, cow behavior (video), analysis of cow digestive system performance, plus other environmental factors included in the normal SVAT investigation process.

WHERE MEASUREMENTS SHOULD BE MADE

As specified, the Committee feels that the most meaningful measurements are those that will be made within the animals' environment. Because current densities and resultant field intensities will vary significantly within a given animal confinement location, it is important to recognize the need to quantify both average animal body exposure and maximum exposure. For example, although the magnetic field intensity may be the highest directly adjacent to the waterline in a specific stanchion, the entire animal is never continually exposed to this level. To this end spot measurements at several locations within an animal's body zone may be utilized to extrapolate average exposure from recorded data at a single location within that same zone. Some suggested measurement locations in nonanimal areas are included to provide a point of reference to animal areas and also different farms.

The following measurement locations are recommended.

1. Magnetic and Electric Fields:
(vertical profile) floor → 6 ft
- a. Animal Exposure Locations
 - 1) front and rear hoof area
 - 2) neck/head/snout area
 - 3) top of back area
 - 4) belly area
 - 5) floor/ground level

Electrical Measurement Protocol for Two Pilot Farms cont.

b. Nonanimal Locations

- 1) transformer pole
- 2) meter socket
- 3) barn service entrance
- 4) other locations as deemed necessary
- 5) *duct, conduit,*

2. Stray Voltage

Present SVAT measurement locations are acceptable.

WHEN MEASUREMENTS SHOULD BE MADE

In general, rural distribution system and farm-load patterns are highly predictable. In most cases the daily-load pattern is not significantly changed regardless of the day of the week. Measurements attempting to quantify effects related to operation of these systems need not be made over lengthy periods of time. Although the 24-hour period normally used during SVAT investigations is sufficient to make an accurate determination of parameter levels, in phase 1 on the first two farms seven-day recordings will be used.

1. Magnetic and Electric Fields

a. Animal Exposure Locations

- 1) spot measurements with power on and off
- 2) spot measurements during farm/system peak loading
- 3) 24-hour recording for seven days

b. Nonanimal Locations

- 1) spot measurements with power on and off
- 2) 24-hour recording for seven days

2. Stray Voltage

Present SVAT measurement procedures are acceptable.

RECOMMENDED INSTRUMENTATION

Although separate instruments may be required at certain times to measure the individual parameters, in order to document the accuracy and time correlation of each measured quantity, emphasis should be placed on the ability of an instrument to simultaneously measure and time-stamp several parameters at once. With this in mind, a data acquisition system with multiple channels that can be used with various

) Electrical Measurement Protocol for Two Pilot Farms cont.

interface probes would be most appropriate for the research project. This type of data collection system will also help to simplify the data analysis portion of the proposed study.

Following the completion of Phase 0 the instruments tested should be reviewed and decisions made on which instrumentation to use for Phase 1.

Stray voltage a dairy problem

By Jim Ragadale
Staff Writer

ST Paul
2-26-86

Stray electrical voltage in barns is hurting production, according to dairy farmers who urged the Minnesota Pollution Control Agency on Tuesday to force further study into the matter.

David Lusty of Milton, Minn., said the problem is just adding to the woes of farmers. He showed the agency board Tuesday a letter he received last week from a committee that turned down his request for a Farmers Home Administration loan. Lusty said he needs the loan to fend off foreclosure.

In the letter, Lusty was told he cannot "operate a successful dairy operation on a farm that is plagued by stray voltage." Although the letter listed other factors that affected the productivity of the farm, the committee wrote: "We believe it must be the stray voltage holding you back."

Stray voltage, to dairy farmers, generally refers to the effects on cows' health and production from electrical energy in the dairy barn.

Traditionally, concerns have focused on the low-level shocks cows receive in mechanized barns and on ways of wiring barns to protect the animals.

But the farmers told the PCA board that those solutions have not worked, and that farmers may be dealing with a subtle source of electrical energy emanating from the ground. They argued that studies of the problem should be altered to consider that possibility.

"This current in the Earth is very definitely a bad problem," Lusty told the board.

The PCA staff, which had gathered information on the subject at the urging of board chairman Duane Dahlberg, a physicist who has studied the problem, recommended that the agency not become involved in the issue at this time. The staff suggested that research on the problem continue and that the state Agriculture Department consider surveying farmers about the extent of the problem.

Milo Mugaas of Erhard, who said he sold his dairy herd after years of declining productivity,

said traditional research into the "shock effect" on cows has not helped. Even after that problem is solved, he said, the symptoms dairy farmers observe — including diseases and lower milk production — remain.

Robert Gustafson, a professor of agricultural engineering at the University of Minnesota who has studied the problem, said many of the symptoms identified by the farmers could be caused by a number of things besides electrical energy.

Dahlberg has argued that electrical energy emanating from the ground, resulting from the grounding of electrical systems, could be a primary source. But Dahlberg according to the PCA staff report is "alone among the academic community regarding his thinking on the problem."

The board members Tuesday expressed concern that university researchers were not considering other possibilities beyond the "shock effect" as reasons for the problem.

CALIFORNIA

8/27/91

TUESDAY, AUGUST 27, 1991

Blue Water Theory Confirmed

PG&E says stray electrical current is entering San Ramon homes

By Michael Taylor
Chronicle East Bay Bureau

A team of scientific sleuths from Pacific Gas and Electric Co., equipped with sophisticated test devices, found evidence yesterday confirming that electrical current is the major suspect in the baffling mystery of blue water that has plagued owners of new homes in San Ramon Valley subdivisions for more than a year.

After consulting with Bay Area engineer and inventor Bill Wattenburg, the team headed by Walt Musso, Walnut Creek district manager for the giant utility, said it had found that direct current that is normally supposed to prevent big steel water mains from corroding has been entering new houses, where it corrodes copper pipes and turns water blue.

"What we've found so far is that there is direct current on the water line," Musso said. PG&E officials

are scheduled to meet today with experts from the East Bay Municipal Utility District to discuss what both utilities have done in an attempt to solve the problem.

"We don't think EBMUD is at fault on this," Musso said. But he added that the East Bay water utility's system of using electrical current to protect its water lines from corrosion "isn't working the way it was designed."

EBMUD officials say they are spending \$3.5 million for a variety of measures to eliminate the blue water problem. They intend to add chemicals at a water treatment plant with the hope that the chemicals will put a protective coating on the copper pipes.

Last week, Wattenburg held a press conference to announce that he had found the cause of the blue water problem — stray electrical current creeping into the new houses along the water lines.

Normally, the current that electrifies the water mains to prevent corrosion is eventually dissipated through moisture in the ground. But because of the five-year drought, Wattenburg said, the current is flowing through trenches around water mains and is then routed into the houses.

Although PG&E officials now believe they have isolated the cause of the blue water, they say they are still having problems with the source.

"Where it's coming from, we don't know," Musso said. Wattenburg has said he is convinced that the stray current comes from electrical anodes that the water district sets at intervals along the water lines.

"That's a possibility," Musso said, "and we're also looking at natural phenomena in the ground."



Jessie King of rural Spring Valley and her husband, Les, found that milk production in their new milking barn dropped after a new transformer was put on a power pole on their farm. They

blame the problem on stray voltage, an unusual electrical phenomenon that they say makes cows jumpy and discontented.

Post-Bulletin Photo by John We

Stray voltage riddles farm

By JOHN WEISS
Post-Bulletin Staff Writer

SPRING VALLEY — Suddenly, Jessie and Les King's farm seemed cursed.

Cows that had been producing splendidly gave less milk. Contented cows had become jumpy, didn't want to be touched and balked at going into the new milking barn.

Les and Jessie became tired and irritable.

"My arms, my bones ... would burn, would ache at night," Les said. "I was really tired all the time, no energy."

It was as though the farm was cursed by gremlins.

"We were ready to tear our hair out," Jessie said. "It was really bad. We thought we were doing something wrong."

It took a few years, but the Kings finally figured out the cause: a quirky phenomenon called stray voltage was haunting their new milking barn.

They searched for solutions, brought in experts, spent more than \$8,000 but continued to lose money. Les, a professional football lineman with the Denver Broncos in the 1960s, also contin-

ued to lose weight, eventually dropping 50 pounds.

Their search also showed they weren't alone. Other dairy farmers in the area have also been bedeviled by stray voltage. They aren't talking because of fears of lower property values, Jessie said.

Selling is not an option for them, she said, because the farm has been in the King family since Abe Lincoln deeded it to them as a favor to a Civil War veteran. Besides, if they sold, someone else would inherit the problem, she said.

So she and some other families that have suffered similar problems have gone public, saying they might file a class-action suit. They are also calling for legislation to force utilities to improving their lines to get rid of the problem.

State action doesn't appear imminent, but a report on stray voltage does. The Minnesota Environmental Quality Board is looking into the phenomenon and will report to Gov. Arne Carlson in one or two months. The governor's office will then decide what to do with recommendations.

Former Gov. Rudy Perpich

asked for the report because of an increasing number of "trouble-shooting calls" made by the utilities, said Larry Michaud, a Public Utilities Commission engineer in charge of examining the issue.

Stray voltage goes through pipes or other metal and thus far has mostly caused production problems with cows, he said. Whether it affects human health is less well understood, he said.

In many cases, utilities correct the problem. In others cases, it remains like a ghost, ready to appear at any time, said Randy Otterness, an electrician who has worked with the Kings.

There are several farms Otterness knows of in southeastern Minnesota that have resisted cures. No matter what he does, he can see the cows are unhappy.

"They kind of are dancing and prancing around in their stalls," he said.

In the Kings' case, the problem showed up when they built a new milking barn several years ago. At first, the barn worked out well and milk production soared, they said. But on April 1, 1985, Tri-County Electric put in a new transformer.

"In 12 days, we couldn't get the cows into the barn," Jessie King said.

They spent several thousand dollars trying to fix the problem and lost even more money in lost milk production.

Darrell Erickson, manager member services for Tri-County Co-op, agreed that some people are having problems, but doesn't see the problem getting any worse.

"We feel we have solved most of them, or at least have satisfied the customer," Erickson said.

In most cases, the problem with the consumer's electric system, but some of the problems have been in co-op lines, he said.

Erickson said it is difficult to predict which stray voltage problems will be easy to solve and which will be complicated.

"Each farm acts differently," he said.

Otterness agrees. He said solving stray voltage is a matter of trial and error.

"You can't walk into the barn with a one-track mind," he said. "Otherwise, you've lost the battle."

Some eligible for telephone bill refund

By JOHN HUGHES
Post-Bulletin Staff Writer

ST. PAUL — Dozens of rural business telephone customers, perhaps even hundreds, are improperly being assessed the 1 percent Rochester sales tax on their long-distance telephone bills.

Those customers are eligible for up to 3½ years of sales tax refunds, a Minnesota Department of Revenue attorney said.

Rochester city officials, who knew at least one person was improperly being assessed the phone tax in 1983 or 1984, said the problem isn't widespread enough, even if dozens of people demand refunds, to put a dent in city revenues.

Cascade Township real estate broker James Kuehl discovered the problem and brought it to officials' attention two weeks ago. Department of Revenue attorney Debra McMartin said Kuehl has been improperly assessed the tax and is eligible for a refund from his long-distance carrier, AT&T Co.

The problem isn't limited to Kuehl or Cascade Township. Dale's Gun Shop in Rochester Township has been paying the tax on its National Telephone Service phone bills, and Starr Concrete in Marion Township has been paying the 1 percent tax through MCI Telecommunications Corp. bills.

Apparently, some telephone companies computers cannot distinguish between a Rochester business and non-Rochester business that has a

Critics say tax isn't managed well

By JOHN HUGHES
Post-Bulletin Staff Writer

ST. PAUL — The fact that hundreds of rural businesses might have been improperly assessed the 1 percent Rochester sales tax on their long-distance telephone bills reveals the difficulty Rochester has in managing its tax, says Senate Minority Leader Duane Benson, IR-Lanesboro.

"This is a creeping Jenny, and we don't know how far it's crept," said Benson, a frequent tax critic. "We know about this, but what else is going on out there?"

But City Finance Director Paul Utesch said the city did not ask the phone companies to improperly collect the tax. He said the error was entirely by the phone companies.

Apparently, some telephone companies computers cannot distinguish between a Rochester business and non-Rochester business that has a Rochester mailing address. As a result, some businesses outside of Rochester are paying the city's sales tax.

Utesch said he received at least one phone call in 1983 or 1984 from a rural telephone customer who believed he was improperly being assessed the tax. While Utesch said he knew the customer shouldn't be paying the tax, it was up to the customer and the phone company to resolve the issue.

He said as far as he knew, the issue had been resolved.

But Kuehl, who had a run-in with Roch-

ester Public Utilities in the late 1980s when the utility acquired part of his land for a power line, said he blames the city for failing to correct the problem.

"It serves to point out in my mind the problem Rochester has in administering some of these taxes," he said.

The problem for the most part seems limited to long-distance bills of businesses and the only way to determine whether the tax is being assessed is to examine a bill. Here's what to do:

■ Add the federal tax and cost of your phone bill. Then, divide the state/local tax by that number. You should get 6 percent—that's the state tax. But if you get 7 percent, you are paying the Rochester tax as well, and you are eligible for a phone company refund for as long as the problem has existed, dating back a maximum of 3½ years.

■ Some phone bills, instead of saying state/local tax, may have two separate headings listed as "state tax" and "local tax." If you have a local tax, you'll probably find it equals 1 percent of your bill. That's the Rochester tax, and you're eligible for a refund.

To get a refund or to correct the problem, contact your phone company, not the state or the city. The number should be on your phone bill.

NOTE: The Minnesota Revenue Department calculates the 6 percent sales tax based on your call total plus the federal tax. So, in a sense, the state is taxing a tax.

Rochester mailing address.

"It was an innocent mistake," said Mike Pruy of AT&T.

The problem for the most part seems limited to long-distance bills of businesses. A Post-Bulletin analysis indicates U S West business and residential customers, as well as AT&T residential customers, are not being improperly assessed the tax.

But there are up to 18 long-distance companies serving rural Rochester customers, and the only way to ascertain whether those residents are paying the bills is to examine a long-distance bill.

McMartin said she has referred the matter to the Tax Payer Information Division, which will in turn notify AT&T. It might file a state tax refund claim. She said

Kuehl would pursue a refund with the phone company, the phone company would get a refund from the revenue department, and the revenue department would deduct the refund from Rochester state aid payments.

It's difficult to say how far back the problem goes. Rochester has had the tax since 1983, but Pruy said the AT&T problem might only

date back to last November, when the company began doing its own business billing.

McMartin said the statute of limitations for gaining refunds would extend 3½ years backward, so non-Rochester businesses with records showing they have been paying the tax for that long could seek refunds from the long-distance companies.

A Department of Revenue official based in Rochester said he will notify telephone companies to stop levying the sales tax outside Rochester if he finds they are doing so.

U S West's Rochester manager, Roberta Risley, said U S West computers are equipped to distinguish between rural and non-rural Rochester residents, so rural residents should not be paying the tax. But at least one U S West business customer, who has a business near Chester, said he believes he, too, is paying the sales tax on his regular monthly phone bill.

Pruy said AT&T contracts with U S West for its residential billings. He said that's probably why rural residents aren't being assessed the tax.

But AT&T does its own business phone billings, which is why more businesses might be unwittingly paying the tax.

Long-distance telephone information is private for the most part, but state officials said AT&T, MCI, and U.S. Sprint are by far the largest long-distance telephone carriers. U S West officials said there are 49,000 phone outlets in and outside the city using Rochester prefixes that begin with 28, but they said it's difficult to specify how many of those serve customers who live or work outside city limits.



Otter Tail Power Company employees Keith Folger (left) and Jerry Martens prepare to take a voltage reading between the milker and barn floor. Otter Tail County dairy farmer Paul Schrock (right) continues milking while the test is taken.

Stray voltage: a mystery no more

By **TIM KJOS**
Staff Writer

Stray voltage — once the bogeyman of the U.S. dairy industry — is no longer as mysterious.

Since 1985, Otter Tail Power Company has conducted over 2,500 tests in its three-state service area for stray voltage.

Most cases have involved dairy farmers, but there have been tests for other customers as well.

Jerry Martens, Otter Tail's stray voltage supervisor, said much has been accomplished in recent years.

"We're continuing to work with stray voltage on a day-to-day basis," he explained.

"It doesn't necessarily mean we're getting a lot of new cases. There's always problems coming up that dairy farmers can't quite get a handle on."

Stray voltage — or neutral-to-earth voltage as now referred to in some circles — is a pesky gremlin for dairy farmers.

When it strikes, milk production typically declines. Dairy cows are es-

pecially sensitive to electrical currents. It can cause them to shy away from a particular part of the barn, feed consumption is lowered and temperament changes occur.

As farmers have discovered, once milk production falls, it can take months to recover.

Curt Markert, project engineer for Wild Rice Electric Cooperative in Mahanomen, said sources for stray voltage are numerous.

Causes could be bad electrical motors, poor grounding, broken wires, moisture in electrical sockets, moisture in ventilation fans or "loading" on transmission lines.

The latter describes customers on a single phase line. The neutral-to-earth voltage on the neutral-to-power line increases, which is then discovered in the milk barn.

"Most of our power lines have ground return. It comes through the neutral. If the neutral isn't able to carry it all then it shows up in the ground," detailed Markert.

When a customer notifies the supplier of possible stray voltage, a company or cooperative service crew

will investigate possible sources. Sometimes they hook up a recorder, which is a remote voltage

It records the voltage from barn to an isolated ground, from transformer pole to an isolated ground and from the milking or stanchions to an isolated ground.

After two or three days the recorder is retrieved and its data through a computer. The computer searches for results during milking and non-milking periods.

If there are irregularities in electrical consumption, the recorder should indicate it.

"If the farmer is not milking you see a large increase in voltage levels then there has to be something that comes on at that time," offered Markert. "You talk to the farmer to see if there is something coming on then."

Wild Rice is currently helping Mahanomen area dairy farmer investigate the cause of stray voltage.

Markert said in nearly all voltage cases they have discovered the cause.

Wed., July 10, 1991

Landowner finds support for plan to oppose power line construction

Tom Pease said he wasn't sure what his trump cards would be when he hosted a rally of friends and neighbors to ask for a moratorium on constructing a 138-kilovolt electrical transmission line that's proposed to pass their Amherst homes on its way from Stevens Point to New London.

Mr. Pease and his colleagues found their unity and a growing public interest in electromagnetic fields (EMFs) to be among their strongest allies since developing their organization, "Promoting Options for Wise Energy Regulation" -- POWER. The transmission line has been proposed by Wisconsin Public Service Corp., Wisconsin Electric Power Company and Wisconsin Power and Light Company.

Questions concerning the health effects posed by EMFs from high-voltage transmission lines on humans and animals initially hadn't been seen as playing a major role in POWER's efforts to obtain a moratorium in construction of the central Wisconsin transmission line, which has been dubbed the "Hoover-Hintz" project. But, POWER members and attorneys are seeing increased statewide and national questions rising about EMF's effects. That itself should be enough cause for a construction moratorium, according to Mr. Pease, a folk-singer who serves as POWER's president.

The moratorium being asked for by POWER's 200 members also would cover construction of any power-transmission lines in the area, since members don't want to have their fight against the construction be successful while increased power transmissions are shifted to alternative routes. That wouldn't be fair to people along those alternative lines, according to Mr. Pease.

Lyn Mosurinjohn, POWER secretary, said most of the group's questions about EMFs boil down to the theme of a button being distributed by POWER members. It says, "Now, from the folks who gave you PCBs and nuclear waste comes EMF! Trust your local utility."

"We're saying, 'Fine, study it,'" Ms. Mosurinjohn said. "But, wait until the EMF studies are done. There's no need to hurry

about EMFs are changing fast, and POWER is hoping that those slow down before the Hoover-Hintz or any other major transmission line is constructed, according to Mr. Pease.

Besides their concerns about EMFs, POWER members also say that the power companies have not given adequate attention to power efficiency. Ms. Mosurinjohn said they aren't necessarily talking about alternative energy sources, but want the companies to use and promote available technologies to increase electrical-energy efficiency by 30 percent to 60 percent. Those methods would allow for continued electrical conveniences that already are in place, she said.

"They aren't doing anything to reduce the demand; they're just building more," Ms. Mosurinjohn said.

"We're not just complaining.



Lyn Mosurinjohn



TOM PEASE

Pease added.

The POWER effort couldn't have come at a more opportune time and place, according to Mr. Pease. Its organization took place about 11 months ago in Mr. Pease's home while a war was brewing over the energy-rich oil fields of Iraq and Kuwait. And, the line was proposed to pass through the Amherst area, which he said is an area with a good sense of activism.

Mr. Pease said he was initially surprised to have found his house filled with Hoover-Hintz opponents when he called a meeting to organize opposition to the line. He said he's since realized the strong feelings that people have against the line and his initial surprise was turned to understanding.

"People around here are just friendly and take care of each other," he said.

Still, he said that donations to the organization and the strength of 200 signed-on members have continued to keep him pleasantly surprised on virtually a daily basis. He said he's also been elated with support offered by attorneys and people who are knowledgeable about EMFs.

With that support, POWER has taken a three-pronged approach toward its moratorium goal. They started by seeking relief through regulatory channels, including the Wisconsin Public Service Commission. POWER has turned to legislative channels, after being unsatisfied with what Mr. Pease said appears to be a "fast-track" effort by the companies to gain PSC approval of the project. If relief is not found there, Mr. Pease said the group plans to turn to the courts.

"Things are going so fast with EMFs," Mr. Pease said. "We're having problems with getting the PSC to recognize that."

A legislative hearing on the matter was held in June, and Ms. Mosurinjohn said there's hope among POWER members that something favorable will result.

Work is still being done through regulatory channels, but Ms. Mosurinjohn said PSC staffing and other factors have limited its effectiveness.

Electrical concerns, yes, but are they stray voltage?

August, 1991

Just when one technical term became understandable, along comes another to mess things up. That's what the average consumer must think of stories concerning stray voltage and electromagnetic fields (EMF) these days.

After more than four years of Wisconsin Public Service Commission (PSC) investigations and hearings, the phenomenon known as "stray voltage" assumed a definition that was set down with some precision in an agency order.

However, in more recent times, farmer concerns have begun to also encompass EMF as an electricity-related source for animal health troubles. Unfortunately, people are mixing the terms "stray voltage" and "electric and magnetic fields," now that both are in the public eye. It's not unusual to read a story where people start off by talking about stray voltage, but end up raising concerns clearly related to EMF.

"Stray voltage has been resolved; it should not be confused with EMF," said Chuck Forster, an electrical engineer who has represented the Wisconsin Electric Cooperative Association on the PSC's stray voltage task force during the proceedings on stray voltage. "There is just nothing left to discover about stray voltage. The techniques for finding it are so good, the solutions are there. The main problem is who should pay for the solutions."

Stray voltage is felt by dairy cattle when the cows come in contact with low-level electric currents that have "strayed" from their usual or desired pathways. The cows, essentially,

become part of the pathway along which the current flows to the ground. These are low voltages—typically .5- to 1.5-volt range—that cows can feel, but humans cannot. Stray voltage, experienced over a period of time by cattle, can translate into a variety of animal health problems.

"During the hearings on stray voltage the farm community wanted to address EMF," Forster explained. He said that both topics at the same time would have been "chaos," so he was agreed to address stray voltage first, and then take EMF in another round of hearings and investigations.

Electrically speaking, according to Forster, by 1983 farmers knew what there was to know about the properties of stray voltage. What the PSC wrestled with for the following several years was establishing threshold voltage levels to define the roles and responsibilities of farmers and utilities in resolving individual stray voltage cases.

"It was a political solution, but a necessary one so we could get out of this argument about who should be doing something," said Forster. "The solution was as good as it could come up with, but I can tell you, EMF is going to be tougher," he predicted.

Electric and magnetic fields exist everywhere there are live electric wires and current flowing along those wires. Unlike with stray voltage, people or animals don't have

(continued on page 11)

stray voltage?

(continued from page 1)

physically touch the electrical pathway to be in an electric or magnetic field. They are fields of force, emanating from electrical wires and equipment, and have come under scrutiny for effects they may have on human health. Research on such effects, most of it as yet inconclusive, is underway.

"When you look at all the possible combinations of fields people are going to get concerned about, you still have a big matrix of possibilities. The discussions immediately get very broad," Forster said, noting that fields vary widely, depending on frequency, amount of current, and distance from the conductor.

"The work that's going to be done by the PSC is to find out at what levels and frequencies electromagnetic fields exist on farms," Forster

continued. "That in itself will be a significant project. After that, they would need to determine if those levels mean anything to cows."

The problem, he said, is that no body of research exists covering EMF effects on cattle. Forster predicted the PSC and Department of Agriculture will find it difficult to even begin establishing "levels of concern" as they did in setting forth stray voltage thresholds.

Besides confusing stray voltage and EMF, people frequently, and inappropriately, lump other electrical problems under the "stray voltage" banner. The television program *60 Minutes* was guilty of this recently when it aired a segment on "stray voltage" dealing with situations that had nothing to do with stray voltage.

"If someone is getting shocked or cows are being electrocuted, then you have something more serious than stray voltage. You have a

failure of the electrical system either on or off the farm," said Forster, referring to a number of cases reported on by *60 Minutes*. "Stray voltage may stop animals from drinking, or it may lead to mastitis over time, but it just can't drop a cow to its knees. You're talking about insulation breakdowns or ground faults."

Forster said the problem is deeper than simply disputing terminology.

"The danger I saw watching that program was that they had an obvious, dangerous situation on that farm that was not being taken care of because they assumed it was stray voltage," he said, commenting that the one fact people usually do know about stray voltage is that it frequently occurs over long periods of time to damage dairy herds. "Don't be complacent figuring 'it's just stray voltage.' A typical stray voltage case will not do this type of thing," he cautioned.

Emotions run high at Stray Voltage Advisory Council meeting

JAN SHEPEL

MADISON

Problems with their own health and that of their children, coupled with devastating problems in their dairy barns drove many farmers to lash out at members of the Stray Voltage Advisory Council and Agriculture Secretary Alan Tracy at a meeting this week.

Farmers frustrated by low or fluctuating production levels and somatic cell counts in their dairy herds, gave vent to that frustration at a meeting Tuesday in Madison.

At the start of the meeting, advisory council farm representative Brad Kolpin asked that the agenda include a time for public comment at the close of the meeting. About 50 farmers came to the meeting with a variety of gripes and the council agreed to hear them after finishing with its other agenda items.

Emotions ran high as farmers talked about their own health and that of their children and dairy cattle. Farmers also voiced frustration with what they see as foot-dragging or worse on the part of some utilities.

Stories were told of production that dropped from 17,000 pounds to 13,000 with no change of management but when the farm was isolated from the power system, production in the dairy barn rose to 20,000 pounds.

Farmers said that when 70 such isolators are needed within a three-mile radius there must be something wrong with the power supply and the utility.

Farmers were also concerned about action or inaction on the part of the Department of Agriculture, Trade and Consumer Protection. Several voiced hostility at the DATCP for not taking action to protect farmers from poor power supplies as part of their consumer protection function. DATCP secretary Alan Tracy was on hand to listen to the farmers' stories.

Tom Beane, a Fort Atkinson farmer who was fired from a position on the state's Stray Voltage Assessment Team said the DATCP has failed Wisconsin farmers as consumers. He also criticized the department for not responding to his request to talk about his firing from the SVAT team.

"I've been waiting since January of last year for a response and I haven't gotten one," Beane said.

Beane said that since leaving the SVAT team, as well as before that, he has received requests from individual farmers to try to help with electrical problems on their farms. In recent months he said he has received threatening letters from various utilities telling him what he can and cannot do on farms.

Beane and his wife said they average one call a day from farmers, bankers and others who are dealing with stray voltage or other electrical problems on farms. He has a backlog of up to 30 farms he has been asked to visit to offer advice.

The upshot of many farmers' comments is that they don't feel they can get any help from the state's SVAT team or its members and have to go elsewhere for answers.

One farmer, Tom Buchholz, said he took the drastic action of having his farm disconnected from the power company's lines and now supplies his farm's power with a diesel-powered generator. He said

the investment in the generator and a backup power unit have allowed his dairy farm to overcome stray voltage problems in the dairy barn.

"I'll never go back on the power company," Buchholz said.

Other farmers complained that members of the SVAT team weren't concerned about cows' behavior or health problems. Linda Hammond, who farms with her husband Ron near Howard's Grove, said cows and heifers in their barn were so severely affected that they had burn marks in the bottoms of their feet. But that was of no interest to SVAT member Dan Dasho, she said.

"He only wanted numbers," she said.

Many farmers were concerned that the utilities may try to remove the isolators that are offering some protection from stray voltage to affected farms. For many, that was why they came to the meeting.

"If you think this is war now," said one farmer. "Wait until those isolators start to go out and there will be war."

Was State Farmer 4-17-97

Renowned lawyer fights utility in "shocking" Allegan County case

MICHIGAN (AP)

A California law firm headed by renowned attorney Melvin Belli is taking on Michigan's largest utility in a lawsuit claiming "stray voltage" is shocking cows on an Allegan County farm.

The suit filed on behalf of Vern and Sally Lanphear accuses Consumers Power Co. of harming or killing as many as 35 cows, Riki Raffner, a spokeswoman for the San Francisco firm Belli, Belli, Brown, Monziona, Fabbro and Zakaria, said Thursday, April 8.

The Lanphears have about 50 head of cattle on their Allegan farm.

"These people are devastated," Belli, 84, whose clients have included Jim and Tammy Bakker and Lee Harvey Oswald assassin Jack Ruby, said in a news release.

"The power company has known for the last 10 or 15 years that their lines have been leaking and they've chosen to ignore hundreds of complaints and concerns of Michigan farmers."

Vern Lanphear, reached at home Thursday night, declined to comment until speaking with his lawyers. Detroit attorney Ralph Sirlin, who also is representing the Lanphears, could not be reached at his office after business hours Thursday.

Consumers Power spokesman Dan Bishop said he was unaware of the lawsuit, although he said the company has faced similar suits in the past.

"Any electrical utility in the country that has farm customers, this has been an issue that has come up," Bishop said. The problem "in 99 of 100 cases is on equipment the farmer is responsible for," he said.

Farmers in Michigan are exempt from federal electrical code standards and can legally alter their electrical systems, Bishop said.

Neither Raffner nor Jack Dougherty, an

attorney with Belli's firm, could say how much the Lanphears were seeking or estimate their losses.

"I think when you look at what kind of economic damage they're facing, it's going to be substantial," Dougherty said.

The lawsuit, filed last week in Allegan County Circuit Court, charges Consumers Power with negligence, breach of warranty, trespass, breach of contract and intentional and negligent infliction of emotional distress.

Consumers Power supplies electricity to about 6 million people in 67 of Michigan's 68 Lower Peninsula counties. The principal subsidiary of CMS Energy Corp. is the nation's fourth-largest gas and electric utility.

Leaking voltage occurs when there is poor grounding of an electrical wire. Electricity seeps into the ground, then is picked up by a building or pipe and can shock a person or animal that touches it, Bishop said.

The charge is occasionally fatal, although more often harms the animals through repeated smaller doses, Dougherty said.

The lawsuit claims leaking voltage has caused decreased milk production, injury and illness to the Lanphears' herd. Many no longer are able to reproduce, the suit alleges.

Dougherty said a voltage meter picked up a reading on one of Lanphear's cows, and seven light bulbs were illuminated with electricity from what was supposed to be a neutral power cable on a utility pole.

In a case at another Michigan farm, a 1,600-pound dairy cow was electrocuted in its stall by stray voltage, Belli said.

"It's just a bizarre situation," Dougherty said. The Lanphears "have a farm that's being electrocuted, and it's driving these cows nuts."

~~Wis State Farmer 4-17-92~~

Focus-group study listens to farmers' stray voltage concerns

JAN SHEPEL

MADISON

Farmers who have stray voltage problems or other electrical problems on their farms just want answers, they "want to keep their heads up, get their cows milking again and get back to it. They aren't interested in suing power companies or getting money."

Gene Kroupa, a market researcher, presented that and other findings to members of the Stray Voltage Advisory Council Tuesday (April 14) at its meeting in Madison. Kroupa, who studied five focus groups of dairy farmers in December and January said he was amazed at how willing the farmers were to express their opinions about this issue. "People want to talk about it," he said.

His market research firm, Gene Kroupa and Associates, was asked by the Department of Agriculture, Trade and Consumer Protection (DATCP), the Public Service Commission (PSC) and the Wisconsin Utilities Association to do the study of farmer focus groups. Utilities paid for the study through their association. All of the parties wanted to get a handle on real and perceived attitudes of dairy farmers about stray voltage and about the state's team designed to assess problems on farms.

Kroupa held five sessions in various parts of the state. Two groups which met on December 11 were divided pretty equally, he said, among those who were dissatisfied with the Stray Voltage Assessment Team (SVAT) and those who were pleased. Another group in Eau Claire was mixed and the group in Green Bay was made up of farmers whose only visit had been by utility company personnel.

A final group of farmers was convened in Madison, made up of farmers who had not had problems with stray voltage on their farms. That group was interviewed to determine how well-known the problems with voltage are among the general farm population and how information can best be delivered to farmers.

Farmers who participated in the focus groups were guaranteed confidentiality by Kroupa's researchers.

One conclusion he reached is that dairy farmers can recognize when something is

wrong with their animals and when that happens they go to the resources they usually use on the farm - veterinarian, milking machine dealer, nutritionist, electrician and local utility.

"These farmers are people who have met a new challenge and overall they did view their local utility as a positive resource. There was a level of trust there, at the initial stages," Kroupa told the advisory council.

When farmers get to the point of calling in the SVAT team, he said, they wanted to be recognized as having gone through the preliminary checks with their other resources. When they called in the SVAT "they were ready to take action," Kroupa said.

"SVAT analysis was a last resort," for many farmers Kroupa said. "It was their court of last hope and then it's time for a farm's survival. At that time it's easy to see why farmers get upset if it takes six months to get their SVAT reports back.

"Farmers would feel better if they got a definitive answer. The guys that are really dissatisfied are those that feel they aren't getting any answers," Kroupa said.

In facing electrical problems on the farm, dairy farmers feel there is a lot of blaming and back-stabbing going on that isn't productive, Kroupa said. The veterinarian blames the nutritionist or the milking machine dealer blames the electrician.

Farmers commented that they feel the SVAT measurements should be separate from the utility investigation. There were anecdotes, Kroupa said, about problems mysteriously vanishing just before a SVAT visit. That contributes to farmers' perception that the SVAT is working with utilities rather than for farmers.

Farmers also feel that the SVAT doesn't have the authority to back up its recommendations to utilities, Kroupa's study found.

Farmers feel the SVAT reports are a problem and Kroupa said he agreed after studying them. "Neither the old or the new versions look very useful to me," he said.

The SVAT is required to give an oral

summary on the spot after an investigation and it would be nice if farmers got a one or two-page report within the week.

Farmers want professionalism on the team and there is no place for some of the comments from team members that farmers reported Kroupa said. "Some comments were unprofessional and should never have been made," he said.

Kroupa noted, however, that in more recent SVAT visits, farmers' reports on team members' professionalism improved.

Kroupa's report made several recommendations which were endorsed by the advisory council. They included:

- A need to sharpen listening and interpersonal relations skills of SVAT members and all persons working with dairy farmers.

- Good customer relations including better communications, calling back to

the farms with information.

- Providing the farmer with a short summary of the SVAT report in short order after the visit with priorities listed of what can be done about the problem.

- The SVAT report needs to be totally overhauled, Kroupa said, and put in a format that is useful to end users.

- The utility should stick with the problem farm until the problem is solved rather than jumping to the next farm, Kroupa said.

- The DATCP needs to coordinate research and education efforts that will better prepare dairy farmers to identify and find solutions to voltage problems.

Kroupa's study didn't find a need to change the composition of the SVAT team, but noted there should be regular feedback from dairymen related to the performance of team members.

See STRAY, page 3

Angry dairy farmers confront officials, demand action to block stray electricity

CHARLES LASZEWSKI STAFF WRITER

The possible effect of stray electricity on the health and productivity of dairy cows has jolted state farmers into action.

They have filed million-dollar lawsuits against electric companies and formed their own Electromagnetic Research Foundation, and on Thursday they vented their anger at state officials who they say are ignoring them.

Stray voltage is the term used for small amounts of electricity that some farmers say shock dairy cows so they quit producing milk and sometimes die. Thirty farmers traveled to St. Paul from around the state Thursday to address the Minnesota Environmental Quality Board, which developed a report on the problem in January.

But after listening to a number of state employees who had worked on the issue, board chairman Robert Dunn said he would not take any comments from the farmers who had signed up to speak. He cited a lack of time and pointed out that the board would not take any action before April, and they could speak then.

As the farmers walked out of the meeting room, one shouted to Dunn that farmers would be planting corn in April and unable to attend. Others shouted at Mike Michaud of the Minnesota Public Utilities Commission and George Burfee of the Environmental Quality Board's staff, as they stood outside in the hallway.

"Goddamn, I hope they all die," said Darrell Franze, 26, who had traveled from Battle Lake in northern Minnesota to speak at the meeting.

"They are shooting it (electricity)

ty) into the ground and they are killing our cows."

His wife, Marnie, stood next to him, tears streaming down her face.

"We've lost 120 cows in the past four years," she said. "These are ones that die or can barely walk. We are not even calling them on the ones who are losing production. The power companies just laugh."

There are a number of ways that farmers say the voltage can get into barns and send little shocks into the cows so that they stop eating, producing milk, or die. A study by the environmental quality board, which sparked the current debate, said that 11 percent of the state's 15,174 dairy farms have been jolted by stray voltage.

Often it is caused by voltage returning to the electric company's substation on the neutral line, which meets resistance and backs up into a barn along metal objects that come in contact with the cows. In those situations, the electric company can often detect the voltage at high enough levels and add an isolator or other equipment to keep the electricity out of the barn. Ninety-nine percent of the farmers reported they were happy with the results, according to the study.

But some farmers, including the Franzes, were equally concerned about electricity that is injected into the ground. Electric companies send the electricity from their substations on the top line, and return about 40 percent of it on the lower neutral line, Marnie Franze said. The remainder is run into the ground.

That electricity will follow the path of least resistance and that

could be through the barn, she said. The farmers want the electric companies to change that, so that all electricity returns through the neutral wire.

Michaud said the path the electricity takes is "anybody's guess."

Michaud announced at the meeting that the public utilities commission will begin making rules on how electric companies must handle stray voltage complaints, but that will take at least a year.

Stray voltage activist fined for damaging power equipment

A local activist in the stray voltage controversy was fined \$278 in Grant County Circuit Court Monday for damaging property while hooking up his own meters to Grant and Lafayette Electrical Company transformers.

Darrel Aden, 58, Blue River, who recently lost a civil case in which he alleged substantial damages from stray voltage emanating from the same utility company's equipment and method of grounding on his farm, entered a guilty plea last week to damaging two riser shields covering electrical wires on transformer poles near his home. Aden has had his farm disconnected from the utility lines for several years.

Aden removed the shields January 23 and 24 to monitor the utility's equipment. According to the complaint, utility workers contacted him after he installed the first meter to warn him that he was breaking the law.

The Blue River man has long contended that stray voltage problems caused health problems in his family and decimated his dairy herd.

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Stray voltage issues coming to a head

^{124 128}
KENYON, Minn. (AP) — Some nights it was so bad dairy farmers Keith and LeAnn Cook couldn't even milk their cows.

"They were wild," Cook said. "They fought to get over the gate. They kicked and bellered."

It took two years and a jolt to a creamery worker to determine that Cook's cows, like other livestock in Minnesota and other farm states, were getting shocked from stray voltage. Electricity leaking from nearby power lines was sneaking into the steel walls and metal pipes in the barn, giving the herd a two- or three-volt charge every time Cook brought them in for milking.

In June, the Cooks won a \$405,000 judgment against the Goodhue County Cooperative Electrical Association, claiming their co-op knew about stray voltage problems since 1979 but took no steps to warn farmers. They also said the co-op failed to inspect and maintain its power lines.

It was the second major stray voltage verdict in favor of farmers in Minnesota this year. At least 11 other stray voltage cases are winding through the state courts as Minnesota and other states consider regulations on stray voltage; that some studies suggest effect 11 percent of Minnesota's dairy operations.

The problem of errant electricity has been recognized by researchers since the 1940s, but there is much disagreement over how

"Something has got to be done. We're not in the 1940s here. We've got new, complex dairy operations trying to use an old system of electrical distribution."

— Michael Zimmer

much leaking electricity is safe.

Wisconsin has a half-volt maximum standard, while the U.S. Department of Agriculture recently lowered its allowable standard to two volts.

Jim Kaster, a Minneapolis attorney who won a \$1 million stray voltage judgement against Northern States Power, calls the USDA level "ludicrous."

"The cows have to light up in the dark" before the federal guideline triggers any action, Kaster said.

NSP paid the Dale and Gloria ZumBerge family of Green Isle \$1 million after its appeal to the Minnesota Supreme Court was turned down last month.

NSP attorney Jim Altman said his company is advising customers in advance about potential problems and sends out crews to deal with them.

One report estimates 11 percent of Minnesota dairy farms are affected by stray voltage. A similar Wisconsin study found 30 percent of the dairy farms there affected. NSP has checked voltage on more than 100 Minnesota farms this

year.

LeAnn Cook said they sued their co-op because it refused to do anything about the stray voltage problem and to bring attention to the issue.

"We tried working with the co-op and they would not help us," she said.

"We couldn't keep cows," Cook said. "They died. They got sick. They got thin. I think we were on the edge of animal cruelty. It was horrible."

After the creamery worker was shocked when he brushed against a bulk milk tank, the Cooks were able to link the voltage problem to the electrical co-op's distribution system.

Cook installed a \$5,500 electrical grounding system near his milking parlor and his dairy herd's milk production shot up more than 70 percent.

Despite that improvement, several attempts to isolate the electricity were unsuccessful and the Cooks gave up dairy farming. They sold their 40-cow herd in 1990 and now farm 380 acres of corn and

soybeans.

"Something has got to be done," said Michael Zimmer, attorney for the Cooks. "We're not in the 1940s here. We've got new, complex dairy operations trying to use an old system of electrical distribution."

The utilities point to other factors, including poor farming practices, improperly installed or outdated wiring, or resistance to the flow of current in grounded power lines.

"Many of the barns are years old," said Bill Czerniak, an engineer with NSP. "And farmers have added to the load without the proper wiring."

"You're obviously going to get different opinions from different parties," said Michael Michaud of Minnesota Public Utilities Commission. "There is no consensus, that's for sure."

Cows have lower internal resistance to electrical currents than humans, which makes them more sensitive to stray voltage.

"People laugh and joke about these cases like they're insignificant," Kaster said. "But this goes to the heart of the issue."

State action is coming on two fronts. The PUC is writing rules that will define the obligations of utilities in stray voltage problems. The Minnesota Environmental Quality Board has a committee

making recommendations to the Legislature and state agencies.

Lawsuits are not the answer for every farmer, Kaster said. "You've got to have very serious, almost debilitating damages to make a claim," he said. "That's why the state has to adopt some standards."

Some farmers believe stray voltage may affect the health of their families as well as their livestock.

Tempers reached the breaking point at a St. Paul EQB meeting in March. EQB members refused to let farmers address the meeting, and over two dozen farmers stormed out of the room.

"Not one damn thing has been done in the past 15 years," farmer Lonnie Nelson told Michaud. "Is something going to be done in my lifetime? Or my little boy's? I've got three kids, and if they're hurt, I'm coming after you."

Farmers have told state officials that they or their neighbors secretly snipped roadside ground wires, something officials warn is illegal and dangerous.

Despite their problems, the Cooks are thinking of getting back into dairy farming. Keith Cook grew up on a dairy farm and wants to set up his two sons, ages 18 and 15, in the business.

"But if we're going to do it, we're going to do it away from these power lines," Keith said.

Power company settles stray voltage cases

■ **STRAY**: Consumers Power Co. has settled 35 lawsuits by farmers claiming stray voltage from the utility's power lines harmed their livestock, according to Jon Marcus, attorney for the farmers.

The lawsuits brought by Marcus were dismissed in Jackson (Mich.) County Circuit Court, court records

LEGAL NOTES

show. Marcus, without getting into details, said producers got some money and assurances from the utility company that the problem would be addressed.

Stray voltage occurs when low levels of electricity leak into the ground, causing minor but repeated shocks to humans and animals.

There are still six lawsuits from Michigan farmers worth \$4.35 million pending against Consumers. The power company will begin meeting with Marcus Oct. 6 to discuss settling the cases.

Cows have lower internal resistance to electrical currents than humans, making them more sensitive to stray voltage. Researchers have recognized the stray voltage problem since the 1940s.

USDA recently lowered its allowable standard for stray voltage to two volts. The rules were vague before, but they allowed more than three volts.

In the largest of the remaining cases against Consumers, Richard Geisen Sr. of Albion claims 4,000 hogs died from stress and dehydration because they wouldn't drink water affected by stray voltage.

Marcus contends the stray voltage is a result of poor maintenance on utility lines, but Consumers says many complaints are due to substandard wiring on the owner's property.

Dairy farmers lose stray voltage case against power firm

ASSOCIATED PRESS

Two dairy farmers who said stray voltage drastically cut their herd's production have lost an effort to win damages from an electric cooperative.

Robert and Lillian Van Alst of rural Bock had sought more than \$200,000 in damages from East Central Electric Association. But a Mille Lacs County District Court jury rejected their bid Monday night.

Jurors found the family 80 percent responsible for the damages it suffered. The electrical cooperative was found 15 percent responsible and the cooperative that provided telephone service was found 5 percent responsible. Because the Van Alsts were found to be more responsible than the defendants, they won't collect damages.

"I won't shut up about the issue; we've gone through too much," Lillian Van Alst said Tuesday. "There are some that are going out of business because of this."

The Van Alsts were represented by Minneapolis attorneys Jim Kaster and Jeffrey P. Anderson, who two years ago won a \$1 million stray voltage verdict from Northern States Power Co. for a southern Minnesota farmer.

In his closing argument Monday, Kaster argued that the only possible cause for the Van Alsts' problems was stray voltage coming on the farm between 1985 and 1990. The family and the utility installed an isolator in 1990 that the family said blocked the stray voltage.

In the 18 months since then, the family says their herd's average production went up 5,000 pounds to 18,800 pounds a year. In Minnesota, the average is 14,400 pounds.

But the utility's attorney, Charles Kennedy of Wadena, said the Van Alsts had no direct proof that stray voltage caused the production problems.

St. Paul Pioneer Press
9/23/92

Central Minnesota

Farmers lose stray voltage su

MILACA, Minn. (AP) — Two dairy farmers who said stray voltage drastically cut their herd's production have lost an effort to win damages from an electric cooperative.

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In the 18 months since then, the family says their herd's average production went up 5,000 pounds to 18,800 pounds per year. In Minnesota, the average is 14,400 pounds.

But the utility's attorney, Charles Kennedy of Wadena, said the Van Alsts had no direct proof that stray voltage caused the production problems. East Central helped install the isolator only at the request of the family, he said, and there was no evidence to show that it worked as the family claimed.

Instead, Kennedy argued, the dairy herd's rise in production could have been attributed to new milking equipment and feeding practices.

SUNDAY, DECEMBER 20, 1992

Countryside

Stray voltage problem Farmers file complaint with PUC

By TIM KING
Staff Writer

Darrell Franze has modified his barn cleaner so it can drag dead cows out of the barn. The 27-year-old Battle Lake dairy farmer uses it for that purpose quite often.

It is routine for his cows to drop dead from the stresses of stray voltage, according to Franze.

Franze and his neighbor, 33-year-old Lonnie Nelson, have long struggled with what they believe are the ravages of stray voltage on their dairy herds. They are on the verge of financial collapse, and as a last ditch effort to save their farms, they filed a formal complaint with the Minnesota Public Utilities Commission (PUC).

The complaint is the first ever filed with the PUC, even though stray voltage allegedly has been plaguing dairy farmers for nearly two decades.

Franze and Nelson filed the complaint with the hope that the state of Minnesota and the power companies would begin to accept some responsibility for what they consider to be a serious threat to Minnesota's dairy industry.

The complaint requests three things:

- that Lake Region Cooperative of Battle Lake, the electrical cooperative for both farmers, install and pay for an isolator that separates the power company's primary neutral wire from the farms' secondary neutral. They are recommending the installation of a Spark-Ap isolator, which they believe is the most effective but least expensive available.

- the PUC complaint demands the removal of the primary neutral away from the influence of the farm neutral, and

- that all other electrical parameters that could cause stray voltage be investigated.

At issue is whether Lake Region Cooperative is responsible for any of the stray voltage that is decimating Franze's and Nelson's herds.

The complaint was heard on Nov. 9 by the PUC. The farmers experienced a victory of sorts. A motion by Lake Region to dismiss the complaint was denied by the PUC. Additionally the PUC agreed to conduct independent tests on the two farms the second week of December.

During the last year the farmers have gathered evidence that may

"Every electron that leaves the power generating station has to return there.

Electricity travels the path of least resistance. That just happens to be through our barns and cows."

David Lusty, Miltona dairy farmer and stray voltage activist.

suggest the power company should shoulder some of the burden suffered by the farmers.

Between April 24 and May 13 Franze clipped all the power company's primary ground wires that were on poles on his farm.

Before he clipped the ground wires his cows were drinking 15-17 gallons of water per day. When he clipped the first primary ground-water consumption increased, on average, 3 gallons per cow. When he clipped the second one, consumption went to 27 gallons per day per cow. By the time all four grounds were cut, consumption was averaging 29 gallons.

Water consumption stayed at that level until Lake Region reconnected the primary grounds in early July. At that time it dropped back to 17 gallons per day and has remained there.

Franze feels the water consumption monitoring is proof that the electrical field from the power company's primary neutral ground is causing problems on his farm. The low water consumption is a symptom of stray voltage that is keeping his herd under constant stress. The stress leads to low production and eventually high mortality among his cows, according to Franze.

"We need an expert to review the results of the water monitoring before any conclusions can be made," said David Weakland, general manager of Lake Region.

By cutting the primary neutral Franze accomplished what the farmers are demanding in the PUC complaint. He removed the primary neutral ground from the influence of the secondary neutral ground.

"Every electron that leaves the power generating station has to return there. Electricity travels the

path of least resistance. That just happens to be through our barns and cows," said David Lusty, a Miltona dairy farmer and stray voltage activist.

Lusty believes that electricity from the primary ground is being conducted through the earth, his barn, and his cows. To reach this conclusion he has conducted a number of studies on his herd.

Lusty also has severed the primary neutral wires at his farm. Two weeks prior to the power company hooking them back up, Lusty had veterinarian Dan Hartsell take blood tests on his herd. Two weeks following the reconnection of the primaries, blood was drawn again.

"What I found in most of the cows was a large differential in white blood cells. That indicated the cows were under stress after the primary was reconnected," Hartsell said.

After Lusty's primary was reconnected Hartsell also noted an increase in sores, swelling at the hock joints, and raw areas where the cows were constantly rubbing.

"David Lusty has an electrical problem on his farm. He is an excellent manager who has tried many ways to solve this problem. This not related to bad management," the Alexandria veterinarian said.

The three farmers aren't only worried about the health of their herds.

"Last June the electrical company installed new equipment at the substation. My wife was doing the milking. The cows just went wild. My wife, who was six months pregnant, got sick and had to leave the barn. The next morning we took her into the hospital because she started contractions. Two of the cows aborted the next day," Lonnie Peterson said.

Although Peterson's wife had a normal delivery at nine months, his 3-year-old son refuses to enter the barn.

"His legs get awfully sore," Peterson said.

The results of the tests taken at the two farms between Dec. 8 and 11 haven't been completely analyzed, and the farmers view them as only a first step.

"We weren't satisfied with the PUC's test procedures. They told us they wanted to keep the costs down

Voltage

continued from page 13A

so they could get the job done quickly. I'm hopeful, however, and view this as a beginning," Lonnie Nelson said.

A formal complaint outlining the test procedures the farmers feel should be taken was filed with the PUC prior to the beginning of the testing.

"There are at least two more stray voltage complaints being prepared by other farmers," Darrell Franze said.

If all else fails they are preparing a group action lawsuit to be brought against the state for what they perceive as inaction on the issue. Former federal judge Miles Lord is representing them.

The end result of the stray voltage fracas is far from clear. It is likely however to change the relationship between the dairy farmers electrical utilities, and the state of Minnesota.

Power line plans drawing protesters

ONEONTA Daily Star 1/8/93
By TOM GRACE

Cooperstown News Bureau

RICHFIELD -- Scores of people from Richfield to Waterville have banded together to try to stop construction of a 115,000-volt power line that the New York State Electric & Gas Corp. proposes to build through the area.

"We had at least 100 people at Tuesday's informational meeting in Richfield and we'll be ready for the public hearing Jan. 27 in Mount Markham," said Cynthia Andela, of county Route 24. "This is like Marcy South again, but this time we're more prepared."

"NYSEG wants us to suggest alternate routes, but we're not going to fall into the trap of pitting neighbor against neighbor. We're determined to stop this thing," Andela said. The \$38 million power line is slated to cross his side yard. "The health hazards and the threat to the quality of life far outweigh anything we've heard from the electric company."

NYSEG wants to build the 26-mile-long transmission line from west of Waterville to Richfield Springs for two reasons, according to Gerald LePage, manager of NYSEG's Waterville office. "The first is that we estimate the demand for power is growing at 1.6 percent a year and by the year 2001 or 2002, we'll have trouble supplying power to the area," LePage said.

The firm also wants to increase the reliability of its power supply, he said. The proposed line would connect to the 315,000 volt Marcy South Line in Exeter, providing an alternate source of electricity to the area. With the new line, customers would not lose power even if another large line were not functioning, he said.

The company wants to acquire property easements by 1994 and complete construction by 1997, but at three recent public meetings along the line's proposed corridor, many residents have turned out in protest, he said.

"I think the fact that this comes so soon after Marcy South has something to do with that. People are concerned, and we're doing our best to answer their questions," LePage said.

The Power Authority encountered strong resistance to construction of its Marcy South line in 1984 when construction was announced.

Andela, a mother of two small children, said people opposed to this project are benefiting from the experience of those who strove to stop the Marcy South Line and from recent medical evidence that power lines may cause leukemia, other cancers and brain disorders.

"A Swedish study shows that people who live near large transmission lines have a 1.4-to-4 times greater chance of getting leukemia," she said, pointing through a Dec. 7, 1992 issue of The New Yorker, which details the study. "People are just beginning to see the damage that electromagnetic fields can do, but the evidence is much stronger than when Marcy South went through here."

NYSEG has handed out brochures about electromagnetic fields, or EMFs, suggesting that small appliances such as electric blankets and hair dryer may pose more danger than power lines, because they are usually operated close to people, but Andela's husband, James, said this information is misleading.

"People don't use a hair dryer 16 hours a day, and if I don't want a hair dryer in my house, I can always throw it out. You can't do that with a power line, and I don't think we should have to sacrifice our children's health on the altar of corporate greed."

Neighbor Barbara Petersen of Perkins Road said she too is determined to stop the line. "It's not needed and I think if we work together, we can make that point."

Alexis Wissell, whose property also is near the proposed line, agrees. "They certainly haven't proven to me that we need another large electric



James and Cynthia Andela and their daughter, Lisa, look toward where a proposed NYSEG power line will pass through their yard.

line here. I am opposed to it."

LePage said NYSEG had anticipated complaints from people whose property will border the line. "I don't think we've heard anything new, so far," he said. The proposed line would follow an existing right of way for about six miles and NYSEG wants new rights of way along a 22-mile corridor, he said.

Cynthia Andela said she and others question the firm's reasons for building the power line. "They say the need for power is growing at 1.6 percent a year, but a decade ago it was growing at 8 or 9 percent, so the growth is actually slowing. If we concentrated on conservation, it would probably stop all together."

LePage said demand is increasing more slowly than before "but still growing and we're seeing

more requests for power."

Andela also said NYSEG has not calculated the damage this line will do to land and land values in the area.

LePage said the new line will not be as powerful and its towers not as imposing as the state Power Authority's Marcy South Line.

Andela said Richfield residents are banding together as the Upper Unadilla Valley Association and seeking assistance from others in the area.

"We know there's strength in numbers and it's been great to see that a lot of people whose land isn't affected yet have started to speak up," she said. "A big fear here is that if they hook up with the Marcy South Line here, soon there will be other power lines heading out of Richfield."

Pelican utility ordered to continue voltage test

Craig McEwen
MINNESOTA EDITOR

Pelican Rapids, Minn., electric utility must continue tests to determine whether stray voltage is causing health and milk production problems on two Otter Tail County dairy farms.

The Minnesota Public Utilities Commission has ordered Lake Region Cooperative Electric Association of Pelican Rapids to have transformer poles and install spark isolators on farms owned by Lonnie Nelson of Clitherall and Darrel Franze of Lake within 15 days of a ruling handed down Wednesday.

But the five-member commission said it was not prepared to say that Lake Region had an inadequate service standard regarding stray voltage or that its practices are unreasonable.

Instead, the commission will continue its problem-solving approach and proceed to the investigatory phase of this matter,

the ruling said.

Lake Region also must conduct on-site testing according to PUC guidelines and make periodic reports to the commission.

The PUC also has given Lake Region 45 days to file a comprehensive voltage reduction plan for the Nelson and Franze farms.

Nelson and Franze must file milk production and water consumption data with the PUC and Lake Region Co-op for February, March and April of this year.

Nelson and Franze were among 57 people who signed a petition in April 1992, saying they were upset with Lake Region's response to complaints they had raised about stray voltage — errant electrical charges that they said were causing problems with their cattle.

They alleged that some type of electrical problem was injuring their cattle, causing infection and illness and resulting in poor milk production and quality, Franze said.

Lake Region General Manager David Weakland said Thursday the utility will honor the PUC request and cooperate fully.

Weakland said Lake Region has been providing free stray voltage tests to its members since the early 1980s. The cooperative has accepted the definition of stray voltage and test protocol as defined by the U.S. Department of Agriculture and the Minnesota Extension Service of the University of Minnesota, he said.

Lake Region has provided stray voltage testing to Nelson and Franze and "have found no unacceptable levels of stray voltage in the cow contact areas," Weakland said. The findings are substantiated by two independent tests performed in December 1992, he said.

But Franze said traditional cow-contact stray voltage is not what is causing the problems in his barn.

"The tests proved to have other kinds of electricity in the cattle's environment," he

said. "Our complaint named off many different kinds of electrical parameters that should be investigated. The independent investigators did look at a broader electrical parameter and found quite a bit."

Lake Region offered to move some electrical equipment on the farms last summer, Weakland said, in exchange for Nelson and Franze providing the utility with milk production and water consumption records.

Nelson and Franze were not willing to do that, he said.

That's because there were gray areas in the agreement that could have relieved the utility of future liability, Franze said.

While he is pleased with Wednesday's ruling, Franze said it will probably take more than what the commission has ordered so far to correct the problem.

"We will find out after they have done the changes. We will be able to tell, and the cows will be able to tell us, if it's doing any good or not," he said.

A8 Thursday, October 14, 1993

Region

THE FORUM

Professor says stray voltage health concern

By Marilyn Wheeler
Associated Press

Put both feet on the floor. That's right, stand on the floor. Now, what do you feel? Pain? Tingling? Weakness?

Whether you're touching the floor of your home or touching the floor of a dairy barn, a Concordia College physics professor says you're exposed to stray voltage.

Duane Dahlberg was an expert witness in the case of a Ray, N.D., dairy farmer

awarded \$429,508 last week for stray voltage harm to his animals.

But Dahlberg is even more concerned about the health problems he believes stray voltage is causing among humans.

"I'm kind of on the outs with utilities and universities for continuing to bring this up," admits Dahlberg. "But it's there, and I've got to do that."

Indeed, he has given other researchers fits since theorizing in 1985 that grounded utility wires were leaking current into the earth.

"Whether it be stray voltage on the

dairy farm, electricity from a transmission or distribution line, using an electric blanket or a microwave or sitting too long in front of a video display terminal — all of those seem to produce sort of a general effect."

Is he some kind of a kook?

"Yes," says Dahlberg. "Except that I'm right."

Jerry Martens, supervisor of specialty testing for Ottertall Power Co., says Dahlberg is dead wrong.

"The good doctor and I are not eye to

eye on this, believe you me," Martens says. "I think he confuses stray voltage with other things."

Both men sit on a steering committee created by the Minnesota Environmental Quality Board to review the issue of stray voltage as it relates to the dairy industry.

In 1992, the task force reported that cows on about 11 percent of Minnesota's 15,174 dairy farms had experienced problems with stray voltage in the previous five years.

No one disputes that when a high volt-

age wire — even an extension cord with exposed wires — touches the ground it leaks electrical current.

It's called a ground fault, and Dahlberg says it is one of the first things a utility trouble shooter looks for.

Martens says the utility industry "takes the position that stray voltage does exist in some cases. When you talk current in the earth, that's totally another issue."

Dahlberg doesn't mind if people think he's crazy. "I've always worked on the edge. Once something is established, then I'm through," he says.

Electric field blamed for milk loss

Cattle harmed
by stray voltage,
farmer says

By CARSON WALKER

Argus Leader Staff

PARKER — Willis Scott says he's trying to sell his dairy cattle in part because of something he couldn't see, hear or taste: electricity.

Scott, 59, said he has lost at least 8,000 in the last two years because of excess electricity flowing from power lines through his milking machines and into his dairy cows at his farm near Parker.

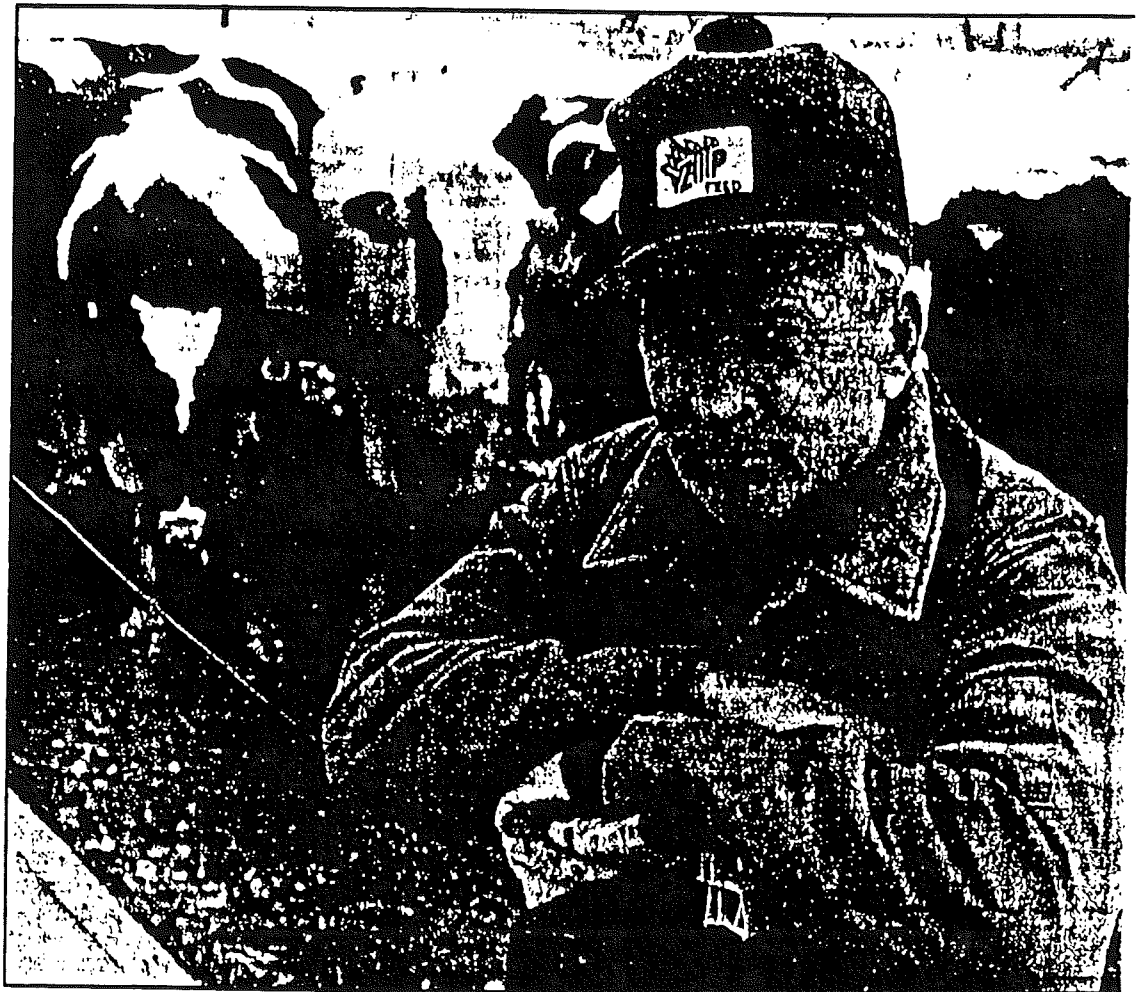
Farmers call the mystery stray voltage. Power companies refer to it as neutral-to-earth voltage.

Whatever its name, Scott said it caused the disease mastitis in his cows, so he had to sell 22 of the 40 he milked.

The problem was fixed, but now, unable to recover from the losses, he's trying to sell his remaining cows and lease out his milking parlor after 37 years of milking.

"We've got to get out because I lost too much money on the stray voltage," Scott said. "That's hard to make up."

Brad Schardin, general manager of Turner Hutchinson Electric Cooperative in Marion, said the company worked with Scott to find the problem. The company stalled a box on the power line that stopped the flow of excess electricity.



Willis Scott said he is selling his cattle because stray voltage affected milk production. Argus Leader photo by BILL HARRIS

"We've put in I don't know how many hours at these places," he said of Scott's farm and others with problems. "That's a good-faith effort on our part to try to find a solution for the member."

In addition to making cows sick, stray voltage has been blamed for causing health problems in people. former forced her family to move out of their house four years

Peggy Lappe of Harrold, 35 miles east of Pierre, said stray electricity from a nearby trans-

"When the bulbs would light in our hands, we knew something was wrong," she said.

People from around the country call Lappe to inquire about similar problems. She is working with the state to do more research about the health effects of electromagnetic fields, or EMFs.

The Environmental Protection Agency recently said that too little is known about the potential health risks of EMFs, so it plans to research the dangers.

Other South Dakota farmers have had problems in their cow herds.

Jim Neugebauer, a milk producer and electrician from Dimock, had stray voltage problems but didn't lose any cows.

A box installed on the power line fixed the problem.

Neugebauer said the causes of stray voltage are endless.

"You could have 500 different farms and you'd have 500 different problems," he said.

Tim Larson of Beresford is still looking for the cause of stray voltage on his dairy farm.

"It looks hopeless at times. Wet, soggy weather like we're experiencing now is the worst," he said. "Voltage will seek the path of least resistance."

But for Eldon Wirth of Hurley, the stray voltage problem is worse when it's dry.

"The year this started it was real dry and the theory was when the soil is dry, it doesn't get good grounding," he said. "As long as the weather is wet, the (milk) production is a little better."

Wirth started noticing reduced production in early 1991.

Turner Hutchinson has spent time and money looking at the problem but can't find a solution,

Electric fields

Symptoms in dairy operations:

- Uneven or lowered milk production.
- Cows extremely nervous while in milking parlor.
- Cows reluctant to enter the parlor.
- Reduced feed intake in the parlor.
- Reluctance to drink water.
- Increased mastitis, an infection in the cow's udder tissue.

Who to call:

Local extension agents or the dairy extension specialist at South Dakota State University in Brookings can provide information about stray voltage in cows. The Brookings number is 688-5488.

he said.

"The most frustrating thing is they don't want to do anything. This is a member-owned cooperative," Wirth said.

Schardin said the company has tried to find the problem but has to make sure the solution it tries is worth the cost.

"We just don't go out and put a bunch of money in a situation before we know if it will solve the situation or not," he said.

Kim Cassle, a dairy extension specialist at South Dakota State University in Brookings, said research at the University of Minnesota shows that stray voltage affects a lot of dairy operations.

"The problem is finding people that are knowledgeable about the electrical end and the cattle end and who know how to wire

things," she said. "It does take a fairly knowledgeable person to take care of it."

Larson brought in a stray voltage specialist from Wisconsin two weeks ago to evaluate the problem and try to find a cure.

"Nothing helps. Nothing does it. You can go on some farms with the most atrocious wiring on it and they don't have a problem. I'm tired of doing this on this side of the pole," Larson said.

Tim Chance, assistant to the operations manager at Lincon Union Electric Co. in Alcester, said the utility has worked with Larson and will continue to try to stop the stray voltage.

"I'm not sure how long we've been working with him," said general manager Gordon Crawford. "To our knowledge I thought the problem was to the degree where we thought it was OK."

Not all stray voltage is caused by the rural electric cooperative, Crawford said.

"The bulk of the problems have been on the members' side," he said. "It could result from 500 to 1,000 items. It's just that type of a matter that's difficult to find."

Larson estimates that he's lost more than \$5,000 on tests, consultants and telephone calls and much more in profits.

"It's thousands and thousands of dollars in herd health problems and loss of production," he said. "What stray voltage does is it makes you look like the worst manager in the world. It emulates a lot of other management problems."

Sibley jury awards dairy farm family \$1 million in suit over stray voltage

CHARLES LASZEWSKI STAFF WRITER

Dale and Gloria Zumberge used to be among the best dairy farmers in Minnesota. In 1976, their cow was a grand champion at the Minnesota State Fair. A year later, they were listed in the top 100 dairy farmers in the state out of more than 30,000 who make their living producing milk.

But starting in 1981, milk production began falling dramatically at their Green Isle farm. The prize cow went dry and had to be turned into hamburger. Nothing they did seemed to make a difference.

Tuesday night, a Sibley County court jury made a difference by awarding the Zumberges and their son, Steve, \$1 million from Northern States Power Co. The jury found that the lost milk production was due to stray voltage from NSP wires, said Jim Kaster, the family's lawyer.

Sam Macalus, NSP spokesman, said the company was "extremely disappointed" with the verdict and was considering appealing the case. He said NSP's position "is that the evidence in the case doesn't demonstrate the reduction in dairy production was due to stray voltage."

The Zumberges weren't available for comment Wednesday — Dale was out on the combine until late in the evening and Gloria was at work.

Stray voltage is a relatively new but serious problem in Minnesota and other farm states, said Duane Dahlberg, an associate physics professor at Concordia College and former member of the Min-

AWARD

VI CONTINUED FROM 1A

nesota Pollution Control Agency board. Dahlberg said several state agencies have begun studying the problem this year.

Both Dahlberg and Kaster said the jury verdict was the largest awarded in Minnesota in a stray voltage case.

"One jury has concluded that stray voltage can have a dramatic impact on milk production," Kaster said of the verdict.

According to Kaster, the Zumberges began automating their farm in the late 1970s and early 1980s but were unaware that those efforts increased the possibility of stray voltage, a subject they knew nothing about.

However, in 1984, after three years of declining milk production, the Zumberges came across a story about stray voltage in a dairy magazine. They called their milking company, which did some tests. NSP was called, and the utility company found 1.9 volts of electricity outside the barn. Other tests found 3 volts inside the barn.

The electricity was coming from a neutral wire, which is supposed to take electricity back to the generator. The neutral wire is grounded in the electrical service box in the barn.

Kaster and their experts contended the wiring used was inadequate to handle the electrical service, and the electricity began flowing back into the barn through the neutral wire. They contended that the resulting irritation to the cows affected their ability to give milk.

In 1984, NSP put up a blocking device at the primary pole where electrical service arrives at the farm, and that successfully halted the problem. But Kaster contended that when NSP put in a new transformer on that pole a few months later, the blocking device was reinstalled incorrectly.

Further, the company had been to seminars put on by the Minnesota Extension Service in 1980 about the problems of stray voltage, so they should have warned farmers about the problem, Kaster said.

As for the Zumberges, they will use the money to pay off creditors who accumulated as the milk production dropped, Kaster said. But more importantly, the verdict "is a name-clearing case for them," because it shows the declining milk production was not their fault, he said.

Stray voltage suit settled out of court for undisclosed sum

A lawsuit filed by a rural Blomkest couple who alleged that stray voltage had harmed their dairy herd for 14 years was settled out of court Aug. 6.

Terms of the settlement were not released in the lawsuit filed Aug. 8, 1986, by Lawrence and Martha Pennings against the Kandiyohi Cooperative Electric Power Association of Willmar, according to the West Central Tribune in Willmar.

However, records showed that an offer of \$120,000 from the power cooperative was filed by the attorney for the couple on July 17. There are no records to show that settlement was accepted.

The jury trial before Kandiyohi County District Court entered its sixth day when the settlement was reached. Judge Arthur Boylan, who presided, said he signed an order dismissing the case with prejudice, meaning it cannot be filed again.

Additional stray voltage funding suggested

CHUCK NOWLEN
& UPI

MADISON

About \$250,000 in utility overcharge settlements should be given to a program to detect and eliminate stray voltage in Wisconsin, state Representative Cloyd Porter (R-Burlington) said this week.

At least \$5,500 per farm is being spent by the state Agriculture Department's stray voltage SWAT team, which is investigating problems on several Wisconsin livestock operations, Porter told the state Senate Agriculture, Health and Human Services Committee April 14.

However, the SWAT team has only \$12,500, donated by utility research organizations, he said.

About 100 state farmers have asked to be investigated by the group; seven operations have been visited to date; and the team hopes to survey at least 15-20, Porter explained.

A legislative committee has approved using utility overcharge settlement money for stray voltage studies, however that idea has been nixed by the legislature's Joint Finance Committee, he said.

He urged backing by that panel and Governor Thompson when anticipated additional overcharge money is awarded to Wisconsin this year.

"If we can go that way, it would be a lot easier than going after taxpayers' dollars," Porter told the panel.

Porter is a member of a broad-based state Agriculture Department committee that developed the SWAT team, which is comprised of an electrician, a herd

manager, a technical expert, a veterinarian, a utility representative and an outside observer.

State Agriculture Secretary Howard Richards reported that the SWAT team might release "meaningful results" of its farm investigations "in another month or two."

Another stray voltage committee member, Random Lake farmer Wally Daggett, said information on stray voltage has been available for many years, but many utilities remain unconvinced.

["A lot of us people on farms never found out about it until we found out about it ourselves," Daggett said.]

Daggett's attorney, Dan Rottier, who handled a protracted dispute with an area utility, said the farmer had accumulated more than \$80,000 in legal bills.

[Daggett won \$1.2 million from Wisconsin Electric Power Company in 1984 in the state's first lawsuit over stray voltage. Daggett contended he had to slaughter his 150-cow herd because of health problems caused by stray voltage.]

Porter's suggestion for \$250,000 might not be adequate because some utilities are spending more than that to "take on the farmer," Rottier said.

["Utilities have spent more learning about it and keeping it to themselves," Rottier said, contending that some utilities have known about the problem since the 1960s but only started admitting it is a problem within the past few years.]

Rottier suggested:

that the state Public Service Com-

mission order rural utilities to include stray voltage information flyers in farm electric bills

- better methods of monitoring stray voltage on farms

- a quicker utility complaint response system

- tighter educational requirements for electricians who claim to be experts in stray voltage

- upgraded rural power lines, which are sometimes more than 60 years old near modern livestock operations.

State Senator James Harsdorf (R-Beldenville) suggested mandatory electrician licensing.

[Whitehall farmer Fred Kulig said milk production on his farm went from 10,000-11,000 pounds per cow to 16,500 pounds after his stray voltage problem was resolved with a blocking device. "I hold it in for utilities or anyone else who should have let us know in the 1970s about the problem. We had to find out about it ourselves," Kulig said.]

[Wisconsin Electric Power Company spokesman Ron Legro said his company is doing as much as it can. "It's an emotional issue," Legro said. "It's hurting their cows and hogs. It was a while before we could begin communicating with them," he said, adding that the company included brochures on stray voltage in bills to farmers two years ago.]

The committee took no action April 14.

Midwest Region

A
Agri News

Thursday, June 13, 19

Dairyman seeking action on stray voltage

By GARY GUNDERSON
Agri News Staff Writer

ST. AUGUSTA, Minn. — A St. Cloud-area dairy farmer who says electrical distribution lines near his farm are inadequate wants township officials to require builders of new housing developments to change the way the homes are wired.

Joe Kenning, who farms about 8 miles south of St. Cloud, said electricity from four new houses that may be built near his farm may shock his cows with stray voltage unless the homes are built with isolators and other features that help keep electricity out of the ground.

Kenning and Duane Dahlberg, a physics professor from Concordia College in Moorhead, told township officials during a May 30 meeting that the current wiring system in the area allows electricity to enter the ground through faults. They also said the electricity that is go-

ing into the ground is putting Kenning's business in peril.

Kenning said his cows were plagued by stray voltage until he put an isolator and other features onto his own farm's electrical system to lessen the amount of electricity entering the ground. But his efforts have been undone because additional new homes have been built in the area. Those homes don't have isolators, he said.

Dahlberg, who is an authority on stray voltage, said the dairyman has done all he can to minimize stray voltage on his farm and the problems now come from off-farm.

Kenning said he has already paid \$6,100 in the past five years to upgrade the electrical transmission systems of houses built near his farm to minimize stray voltage, and he said he doesn't want to pay more every time new houses are built.

"It's not fair for me to spend all

this money and then have new people move in," Kenning said.

The developer, Dan Bloch, said he feels like he's caught in the middle because he wants to build his house and cannot do so until his plat is approved. Bloch said his plan for the 30 acres he bought is to build his own house and sell three two-acre lots to help pay for the project.

Township board members said they are sympathetic to Kenning, but said they probably cannot require a higher standard on the wiring of some new houses because of the possible stray voltage threat.

Dahlberg estimated the system Kenning wants Bloch to install would cost about \$1,000 or more per house.

The township board reiterated this view when Dahlberg told them he could not guarantee that the wiring system Kenning wants for the new houses would not allow at

least some stray voltage into the ground. There are too many variables to accurately predict where stray voltage will go, Dahlberg said, because the electricity will follow watercourses, aquifers and other physical features that are not entirely mapped. Where the electricity in the ground goes will only be known after the houses are built, he said.

Frank Kundrat, a St. Cloud attorney who represents the township board, said the board should table the issue until Kenning can meet with Bloch and Stearns Electric Association officials. Board members agreed, and tabled the issue until their next meeting.

Kundrat added that township officials probably don't have the power to require upgraded wiring to minimize stray voltage. He said Kenning should probably contact the Stearns County Board, which has to approve all housing projects OK'd by the township board.

Kundrat also said Kenning can

sue in civil court if he feels stray voltage from houses is causing harm to his cows. But Kenning, who said new stray voltage may destroy his herd's profitability, said he wants to prevent the problem and not act after it happens.

Kenning said that he wants to stay in the dairy business and pursue lawsuits.

Study: Utility workers face cancer risk

NEW YORK (AP) — Utility workers with heightened exposure to magnetic fields had three times the risk of one kind of leukemia than those with less exposure, a study found.

Some previous studies have found similar results, but one expert called the new work one of the best studies on the subject so far.

The study's authors, however, cautioned that the results do not show that the magnetic fields actually caused the leukemia. In fact, some detailed analyses gave results inconsistent with that idea, they said.

The study covered 20 years and more than 220,000 men. Besides the findings involving acute myeloid leukemia, it found weaker evidence for a possible elevated risk of a brain cancer called astrocytoma.

"Our study does not provide a final answer to the question" of whether electromagnetic fields are linked to cancer, lead author Dr. Gilles Theriault of McGill University in Montreal said in a statement Wednesday.

"It also indicates that the number of workers who may have been affected by the problem is very small, estimated at

one in 200,000 workers."

The study is to be published in the American Journal of Epidemiology. It involved employees of Ontario Hydro and Hydro-Quebec in Canada and Electricite de France-Gaz de France in France.

In the way it was carried out, it is "one of the best if not the best study of this issue ever done," said Dr. David Savitz of the University of North Carolina School of Public Health in Chapel Hill, who studies the field.

Still, "the results are not definitive or conclusive," he said.

They may imply that if electromagnetic fields are linked to cancer, the effect is modest, he said.

"Until now, I think it was easier to say weak methods may have been hiding something much bigger, and you can't say that with the same confidence you could before this study," he said.

The study focused on magnetic fields rather than the broader issue of electromagnetic fields. Savitz said researchers think if there is a hazard it probably lies in magnetic fields.

Study finds cancer linked to electricity

Tacoma, Wash. (AP)

Amateur radio operators in two states appear to die at abnormally high rates from several forms of cancer, suggesting a possible link between cancer and electromagnetic fields, a state epidemiologist says.

Others cautioned that evidence of such a link has been inconsistent and that other factors may be involved.

Dr. Samuel Milham Jr. of the Washington Department of Social and Health Services studied the deaths of 2,485 Washington and California ham operators between 1979-1984.

He reported in the American Journal of Epidemiology that 29 leukemia deaths would be expected in a group of people that size, but he found 36 deaths. Statistically, he expected to find 72 lymphatic and blood-forming organ cancers, but found 89. And he expected to find 67.6 deaths from prostate cancer, but found 78.

The study "indicates that amateur radio operator licensees in

Washington state and California have significant excess mortality due to acute myeloid leukemia, multiple myeloma and perhaps certain types of malignant lymphoma," Milham reported.

Milham said even more disturbing studies have come from other scientists. University of Colorado and University of North Carolina studies have found unusually high levels of leukemia among children who live near power lines, he said.

Dr. Noreen Harris, a Tacoma-Pierce County Health Department epidemiologist, said many questions remain on the issue.

"People living near power lines may be poor and other (cancer-causing) things may be in their environment," she said.

"We are concerned and we are trying to keep abreast of the studies being conducted by national organizations," said Ed Kluga, manager of electrical distribution for Tacoma City Light. "When definitive data is available, we will take action. As of now, the studies show nothing conclusive."

Stray voltage Continued from page 1B

of voltage hurt cattle and other livestock. Cows are more sensitive than humans, partly because they have low internal resistance to electrical currents. But the fact that a cow gets a shock doesn't necessarily shrink a farmer's milk check. Wisconsin has set one-half volt as the threshold for adverse effects on animals, a level utilities argue is too low.

Convinced that the problem wasn't of their own making, the Kings kept returning to stray-voltage theories, poking into murky areas beyond scientific consensus. They bought devices for measuring voltage. They keep elaborate report cards on the cows' behavior, correlating it with weather and other factors, and they compare notes with other farmers.

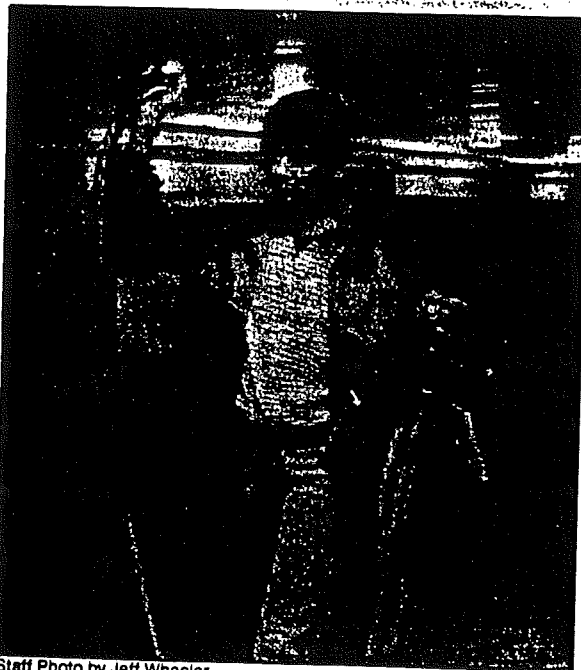
Many farmers complain about electricity they can't always measure, problems from elusive electromagnetic fields and unpredictable power spikes. While some scientists suspect impacts on animals and humans from the magnetic fields surrounding power lines, there has been little research on the topic.

Another theory, that some farms are zapped by underground currents from grounded wires, received widespread publicity in Minnesota during the mid-1980s.

The Kings worry for their own health, as do many farmers who claim to have inexplicable voltage problems. Les King, a former high school football coach who made a bid to play professionally for the Denver Broncos in the mid-1960s, said he has lost 50 pounds over the past five years and doesn't know why.

So intense is the frustration among such farmers that some of them confessed in meetings with state officials this fall that they or their neighbors have secretly snipped roadside ground wires, something officials warn is illegal and dangerous.

The Kings and other farmers got a psychological boost Oct. 9, when the ZumBerge family near Green Isle won a \$1 million judgment against NSP because of stray voltage problems. In the mid-1970s, the dairy herd run by Dale and Gloria ZumBerge and their son Steven ranked among the state's top 100 milk producers. When it suddenly fell below the state average, the ZumBerges groped for reasons. Only after they read about stray voltage in



Staff Photo by Jeff Wheeler

Jessie King carried a milking apparatus from one cow to another in her family's milking barn in Spring Valley.

a magazine did they call NSP.

NSP installed a device to block stray voltage from its power lines in August 1984. The herd improved, but not to the mid-1970s levels, and the ZumBerges sued NSP to recover lost income. Among other claims, the farmers said NSP should have warned them about stray voltage.

Eventually the case ended up in the Minneapolis law firm of Nichols, Kaster & Anderson. Its offices in the

IDS Center became classrooms for the study of Ohm's law of electricity, animal physiology and other topics in the complex technology surrounding the issue.

In late 1989, an expert hired for the case examined NSP's device and found it faulty, something the ZumBerges' lawyers said NSP had known for two years. The 2½-week trial became a duel among experts, with witnesses for NSP pointing to the ZumBerges' management and

farming practices. NSP has not decided whether to appeal the verdict, lawyer Jim Altman said last week.

No one knows how many legitimate stray voltage problems there are in Minnesota. Wisconsin legislators have allocated nearly \$300,000 since 1988 to address the problem. The state created an analysis team — including an electrician, a veterinarian, an electrical engineer and a farm management consultant — to visit farms with problems.

Farmers are required to pay \$100 for the analysis, which can take several days; their utilities pay \$500.

About 30 percent of the 50 Wisconsin farms analyzed since early 1989 have had stray voltage problems, said team electrician Mark Cook. For the rest, "the symptoms were created by other nonelectrical things such as pipeline problems, feed problems and palatability of the water," he said.

On the farms that did have stray voltage, the team concluded that 70 percent of it came from utility systems, he said. The Wisconsin Public Service Commission can require utilities to fix problems when they are found. NSP's Wisconsin subsidiary has petitioned the commission for a rate increase, listing among other factors that it expects to spend an additional \$333,550 next year dealing with stray voltage problems in Wisconsin, said Mike Ritsema, an auditor with the commission.

In Minnesota, where 30 percent of NSP's customers are outside the Twin Cities area, no such expenditures have been budgeted, said Ernie Hiatt, NSP's expert on stray voltage. NSP has given farmers brochures on the subject, sponsored seminars and investigated stray voltage complaints as part of its routine service, he said.

How far utilities should go is on the subjects being discussed at a series of meetings organized by Environmental Quality Board 11 fall. Agencies participating in the meetings include the department of Agriculture, Health and Public Service plus the Public Utilities Commission. Their study of complaints from farmers, utility records and policies in other states is expected to take about two months.

Right out of the tabloids comes jolting stray voltage hypothesis

By CATHY RUNYON

The stories seemed like clips from B-grade science fiction movies, or spooky tales told around a fire by campers on a summer night.

The dogs in an Allegan kennel were prize-winners, but if they produced any litters at all, the pups were mutants or died for no apparent cause shortly after birth. The dogs would not drink from the water buckets, but ate snow or drank from puddles. There were no mice in the kennels, not even any droppings. There were no frogs in the pond, no mosquitoes in the air. When the dogs were taken to another kennel, however, they produced normal litters.

A Coopersville dairy's cows had inexplicably high rates of mastitis. They had to be driven into the barnyard, and eventually some could not be coaxed in from the field at all.

A Grand Rapids Township farmer has been knocked to the ground repeatedly by what seems like lightning. His horses and cattle have holes burned in their feet.

A Remus farm family has been ordered by the doctor to move out of their house. Headaches, joint pain, and soreness in feet and legs that eventually prohibits walking has developed since a new electrical service was installed. The Emergency Task Force of the Michigan Public Service Commis-

sion heard these stories and more during seven public hearings conducted over the past three months. Investigating a phenomenon called "stray voltage" or "objectionable electricity," the task force must now analyze the anecdotal material and documented reports and try to determine whether an actual problem exists, and if it does, who is responsible to fix it.

Upjohn toxicologist Thomas Marks, who first began investigating the Allegan kennel mystery, told the committee, "I think what we have is known in science as a hypothesis." Marks said that, having exhausted his research possibilities and finding no

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VOLTAGE

Continued from Page 1

probable cause for the reproductive problems of the dogs, he gave up. Then, about a year ago, he heard about the phenomenon of stray voltage. When he revisited the kennel, he took electrical testing equipment.

"At the water buckets, it spiked at four volts," he said. He said stray voltage was discovered intermittently around the kennel.

"Now we can go in and try to document cause and effect," he said. "All I'm asking is that we test the hypothesis."

The problem is especially troublesome to dairy farmers, according to Rockford electrical engineer Lorin Katerberg. He said he has studied about 60 Michigan farms where faulty electrical systems are often complicated by soils with high acid and moisture contents caused by animal wastes.

Katerberg said visible phenomena such as entire herds of cows flipping back their ears when an electrical ground is connected, dogs which refuse to leave the house, and tractors bursting into flames are system-related in about 4 percent of the cases he has investigated.

"There are some site-related phenomena, and some bogus claims. After about two days we generally know whether there's a problem or whether there isn't," he said.

Tom Beane, a former member of Wisconsin's Stray Voltage Analysis Team, now is a private representative for property owners who believe they are suffering from stray voltage. His experience with more than 400 cases leads him to say that communication between farmers and state utility regulators has been ineffective.

"Some farmers have been waiting two years for a report," said Beane. "Some of the reports are two-and-a-half inches thick. There's a saying that if a farmer can't read the item between the mailbox and the house, it won't be effective."

He urged the Michigan task force to avoid too much detail and documentation.

"Farmers don't need documentation, they need solutions," said Beane. "Within six months, some farms are out of business."

Beane said the makeup of the task force, should it continue, would be pivotal to its success. He said representatives from agriculture, local utility companies, and human health fields must be included with regulation personnel and utility installers.

Katerberg said the system itself must change if the increasing trend in stray voltage complaints is to be reversed. An aging electrical distribution system dating back to the 1930s must be replaced, he said, and it must be done according to the same code demanded for new construction today, an expensive proposition for utility companies.

Beane said the problem will worsen with population density and the proliferation of underground transmission systems, which create electrical loops with high-voltage lines.

"When it becomes an urban problem, then I think we'll see results," he said.

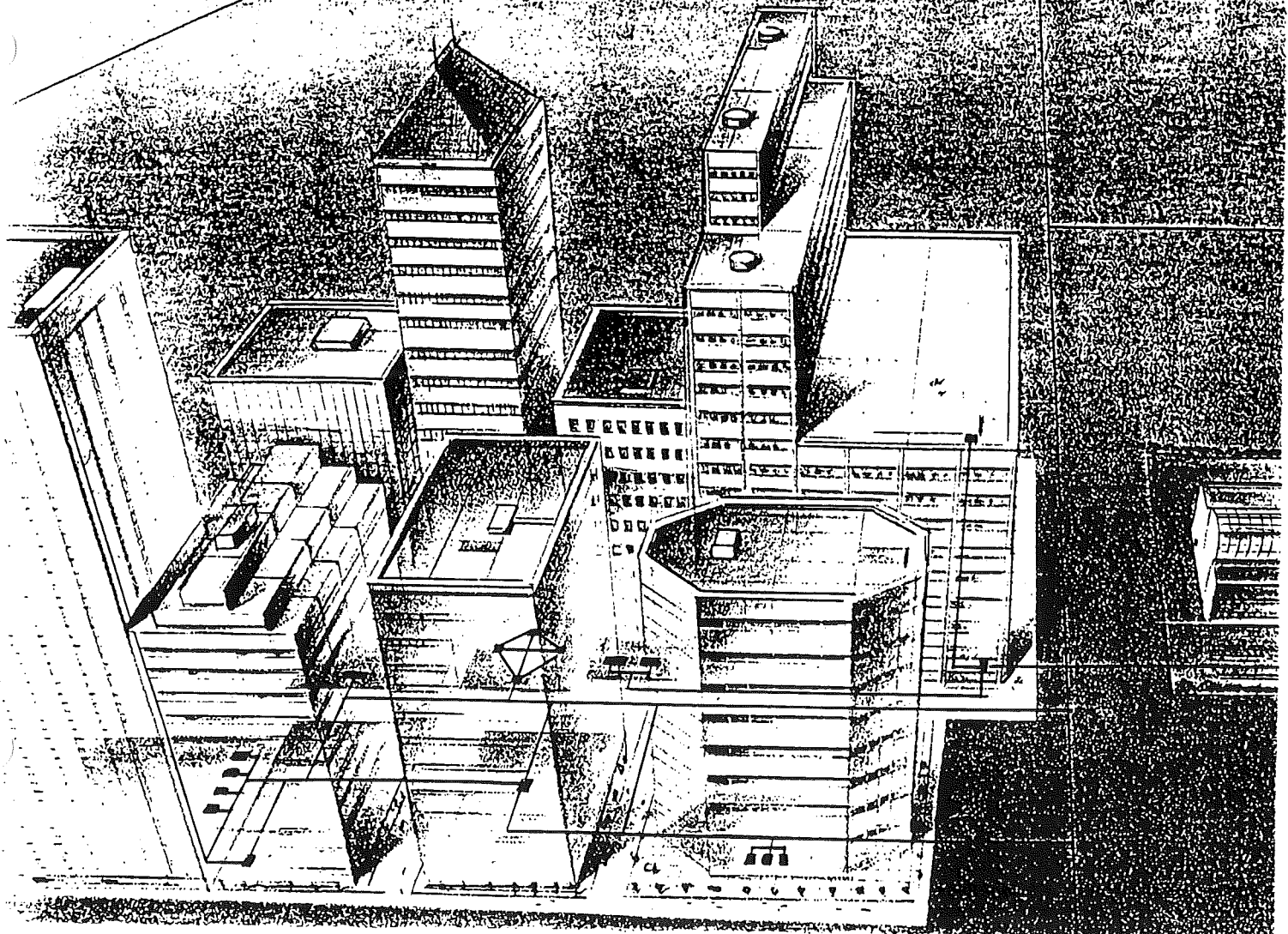
Distributed Generation

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ELECTRIC POWER RESEARCH INSTITUTE

EPRI JOURNAL

APRIL/MAY
1991



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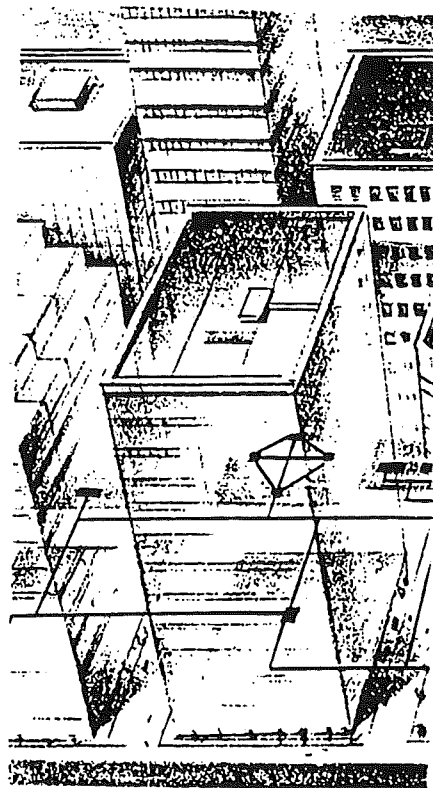
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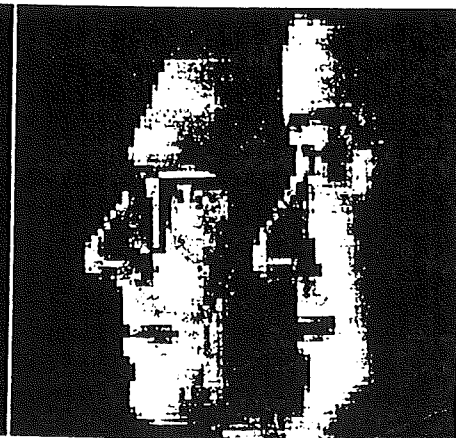
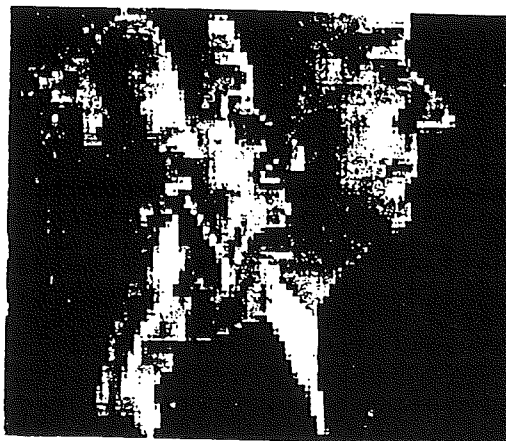
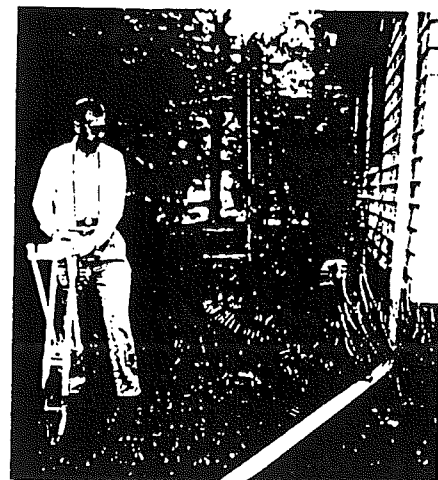
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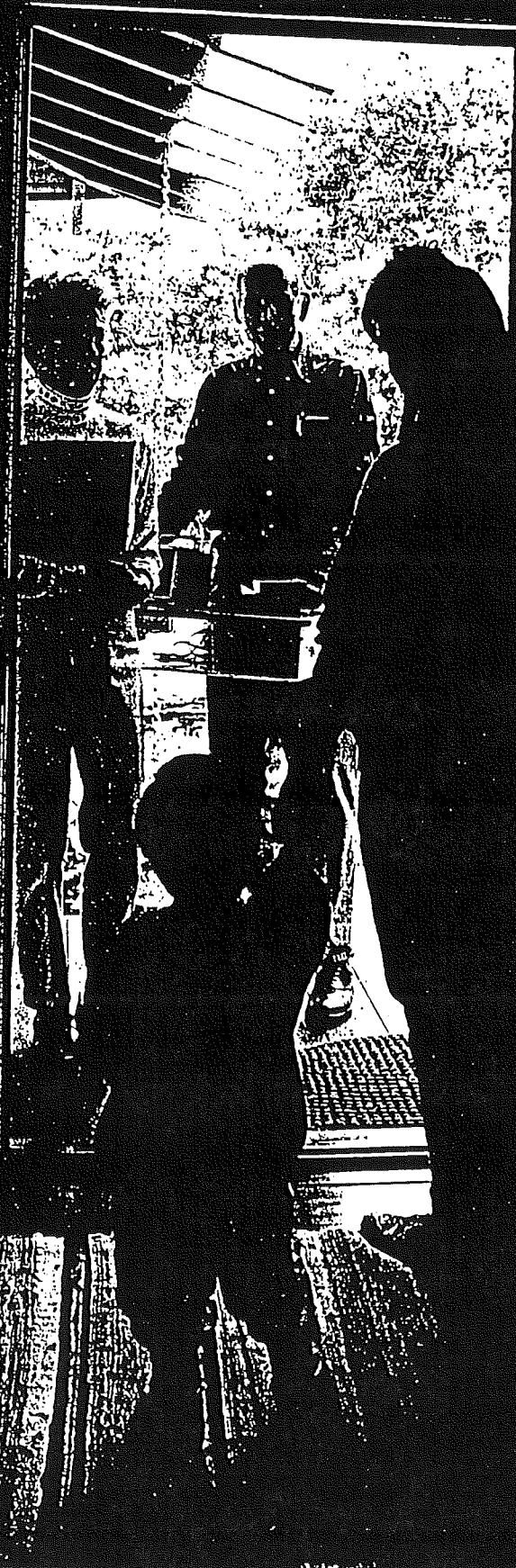
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EMF IN AMERICAN HOMES



by John Douglas



THE STORY IN BRIEF

Although public concern about exposure to electric and magnetic fields (EMF) has risen because of recent epidemiologic studies, little is known about the major EMF sources and average field levels in homes. To provide such information, EPRI has conducted a nationwide EMF survey of 1000 residences, designed to identify all significant sources of 60-Hz magnetic fields and estimate the percentage of homes where average fields exceed various levels. Preliminary analysis indicates that the most common residential EMF sources are appliances, ground currents, and power lines. Results of the survey can help guide utilities in responding to customer queries, provide valuable information for ongoing health studies, and suggest directions for field management research.

As interest in the possible health effects of exposure to electric and magnetic fields (EMF) increases, the question of which EMF sources are most significant gains importance. Although epidemiologic studies have indicated possible connections between exposure to magnetic fields and certain forms of cancer, little is known about which exposure characteristics may be most important—brief encounters with intense fields, for example, or chronic exposure to low-level fields. As public concern rises, more information is needed on residential field characteristics and levels and on the major sources of EMF in homes.

To help address these issues, EPRI has conducted a nationwide survey of 1000 residences randomly selected within the service areas of 25 member utilities. Specifically, the survey was designed to identify all significant sources of 60-Hz magnetic fields in residences and to estimate the percentage of residences where average fields exceed certain levels. Also explored was the relationship between sources and fields, as well as the way fields vary with location and time. Fields from appliances, for example, tend to be high close to the appliance when it is operating; those from power lines and grounding systems are lower but more pervasive in a residence. Such information about field sources will be critical for efforts to predict and manage fields under various circumstances.

Data gathered in the survey will also be used by health effects researchers to help resolve some remaining uncertainties in epidemiologic studies. Specifically, a careful analysis of residential fields and nearby power line configurations may help shed light on the significance of so-called wire codes, qualitative descriptions of power lines used to estimate past EMF exposure in several epidemiologic studies. The survey was not intended, however, to measure personal exposure to fields, since that depends on people's activities—how long they spend in each room, for example, or how close they stand to certain appliances.

"This study has produced a large data-

base showing what magnetic field sources and levels are in real homes," says Karl Stahlkopf, director of EPRI's Electrical Systems Division. "The EMF issue still has a lot of unknowns. This survey has shown what levels of fields are commonly encountered in homes; now our job is to evaluate practical ways to reduce these levels, if warranted. The residential survey can serve as a valuable resource for future research, both in helping resolve uncertainties about health effects and in establishing priorities for field mitigation efforts."

Making the measurements

Because of the magnitude and complexity of the 1000-home survey, a pilot study was initially conducted to develop techniques for magnetic field source identification and field level measurement. These techniques were then applied, during Phase 1 of the survey, to 162 residences to check the validity and practicality of the survey protocol. As a result of this work, a few minor modifications were made to the protocol, mostly to improve the efficiency and reliability of the measurements. The remaining homes were then surveyed during Phase 2, with data collection completed in 1992. The survey protocol was developed by the staff of EPRI's High-Voltage Transmission Research Center (HVTRC) in Lenox, Massachusetts.

The instrument used to measure fields in residences selected for the 1000-home survey was a stand-alone recorder called STAR, which was developed at HVTRC. Based on microprocessor technology, STAR is a highly portable device that samples and records fields along three axes at specified intervals. With a resolution of less than 0.1 milligauss (mG), the device is able to detect the low-level fields generally encountered in residences.

During the survey, STAR was used in two modes. In the first mode, which involved measuring the spatial distribution of fields, a STAR unit was mounted on a calibrated surveying instrument called a VANA wheel. The wheel was then rolled throughout the interior of a residence and around the yard in order to construct a

computerized profile of field strengths along the paths of travel. In the second mode of operation, STAR units were used without the wheel to record changes in fields over time in specific areas and to measure spot levels at different distances from appliances.

Measurements at each residence were taken by a two-person survey team, usually accompanied by a representative of the host utility. The first visit to each residence lasted about an hour. One team member worked mainly inside, sketching the living areas and using STAR to make a map of fields inside the home. The second team member worked mainly outside, sketching the outside perimeter of the building, indicating the position of power lines, photographing the residence and power lines, and mapping a profile of the fields from the lines. Measurements of fields near selected appliances were made by using three STAR instruments attached to a support, so that field strengths were recorded at distances of approximately 1 foot, 2 feet, and 4 feet from appliances. Four recorders were then left inside the residence for 24 hours. The next day, the survey team returned to collect the recorders and to make any repeat measurements for which a preliminary data analysis suggested a need. After these measurements were made, the STAR data were downloaded into a personal computer for analysis, which included the production of graphs showing field profiles inside and outside the home.

Survey teams were selected and trained by Enertech Consultants of Campbell, California. Most of the teams were retired couples, and one member of the couple usually had some technical background. Each team received one week of training at Enertech, which focused primarily on how to interact with residents. Then the teams went to HVTRC with an Enertech trainer to learn the measurement protocol. Finally, each team spent a week practicing in the homes of volunteers in Baltimore, again under the supervision of an Enertech trainer.

"We were particularly concerned to find teams that would stick together through the whole survey," says Michael Silva,

president of Enertech. "We found that these teams were well accepted; retired couples don't look very intimidating. Taking a personal approach is the key to establishing the trust that is needed in a survey like this. Several people even made cookies for the teams, and the utility representatives generally had pleasant experiences. One even said that the survey 'set a new standard for good relations on a touchy subject.'"

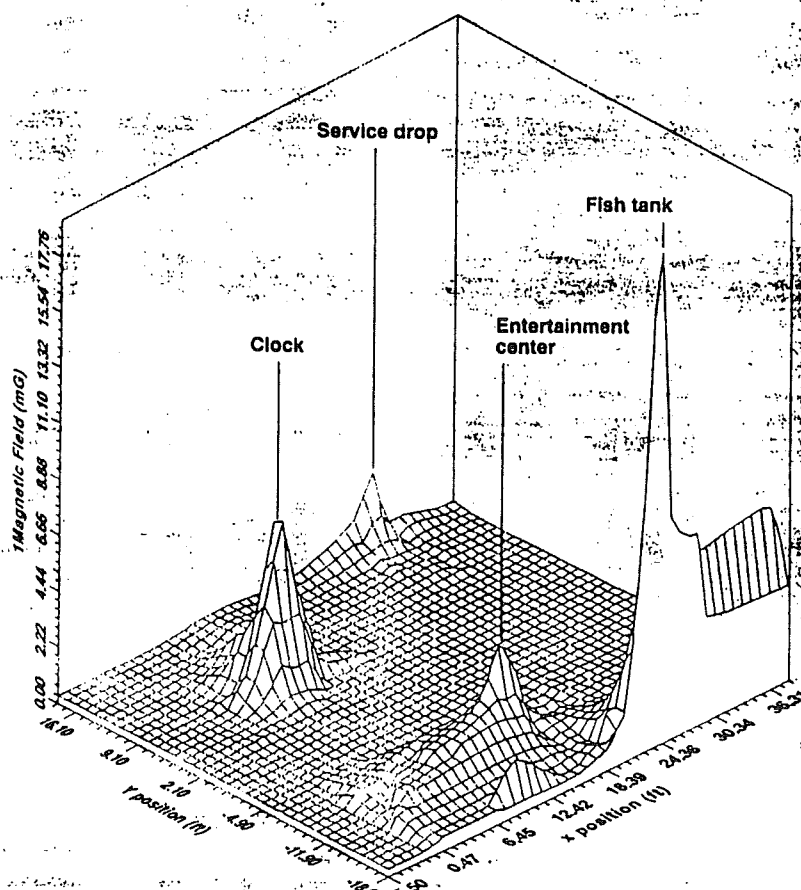
Given the large amounts of information collected for each residence, data management became a complicated task. Four

software packages were developed specifically to characterize residential fields; the work was conducted at the computer facilities of HVTRC, which is responsible for data analysis related to the survey.

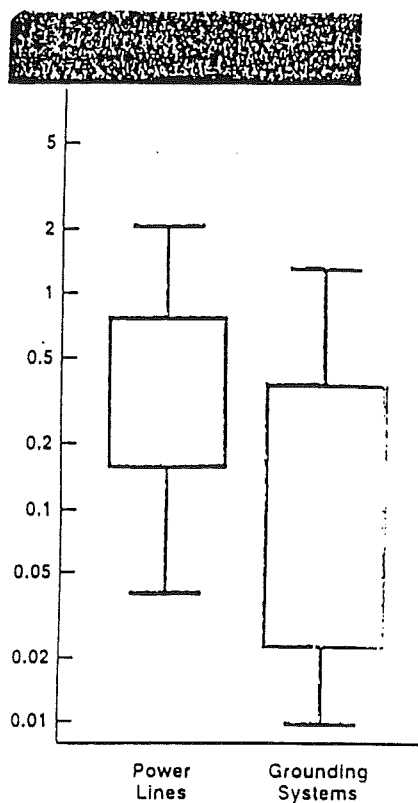
Initial results

An interim report based on measurements at the first 707 residences has recently been published (TR-100194), and a final report on the project is expected later this year. Preliminary analysis of data from the first 707 residences found that the most common sources of 60-Hz magnetic fields

RESIDENTIAL FIELD CONTOURS The STAR/VANA data can be used to produce a computer-generated contour map of magnetic fields in a residence. In the living room shown here, field levels were generally well under 0.5 mG. However, a clock, the utility service drop, an entertainment center, and a fish tank motor all produced peak fields, with the latter registering a surprising 20 mG.



60-Hz Magnetic Field (mG)



MEDIAN FIELDS A key result of the nationwide survey was information about the distribution of median magnetic fields produced by power lines and by the grounding systems in homes. In each plot, half of the median values lie within the range indicated by the box, with another 20% lying in each of the two ranges indicated by the "whisker" lines. The top 5% and the bottom 5% of values lie above and below these lines. Generally, power lines are the dominant source of fields for a home considered as a whole, but in smaller areas, such as parts of a room, fields from ground currents are often larger.

were electrical appliances, the grounding systems for residences, and power lines. Normally, internal wiring was not a significant field source in homes. Results showing the importance of grounding systems were particularly interesting, since currents in water pipes and other grounding paths may be the major nonappliance field source in many homes. The field from ground current varies with electrical loads on the premises or even at neighbors' houses.

The median field value for all rooms in the residences—based on spot measurements taken without reference to specific sources—was 0.5 mG. Kitchens generally had higher median field strengths, 0.7 mG. About 10% of the homes had all-room median field values of 1.9 mG or more; 5% had values of 2.7 mG or more.

The highest peak fields were produced by appliances. Eight different appliance types were considered, and photographs were taken of each appliance to aid in further evaluation of subsets, if desired at some future time. At a distance of 10.5 inches from the appliance—the closest measurement point—a median field of 2.5 mG was found for 367 refrigerators surveyed, 8.5 mG for 272 electric ranges, 6.6 mG for 397 color television sets, 36.0 mG for 371 microwave ovens, and 14.3 mG for 97 analog clocks and clock radios. As expected, fields from appliances were found to fall off more rapidly with distance than fields from power lines and grounding systems; refrigerators, for example, produced median fields of 1.1 mG at 22 inches and 0.4 mG at 46 inches.

For the 24-hour measurements, the dominant field sources were power lines and grounding systems. Power lines were generally the most significant source of fields when the house was considered as a whole. In smaller areas, such as parts of a room, ground currents were often the predominant source.

In a few cases, special wiring arrangements produced significant fields. Old-fashioned knob-and-tube wiring, for example, was found in about 7% of the residences. Such wiring produces higher fields than modern wiring because the wires are spaced more widely apart than

in today's cables, so fields do not cancel as effectively. Also, a few of the surveyed homes have radiant heating units in floors or ceilings, which use loops of wire that can contribute to higher field levels in living spaces.

"The 1000-home survey has produced a definitive database on residential fields that will be mined for years to come," says EPRI research manager John Dunlap. In particular, it provides a major planning tool for future research on field management, enabling us to concentrate on the most important sources. EPRI will spend more than \$4 million in 1993 on evaluating ways to manage magnetic fields from the power delivery system, including grounding."

The question of grounding

Grounding one wire (the neutral wire) in an electrical distribution system is generally required because it provides an important safety feature for customers: if there is an electrical fault, grounding permits fast operation of a fuse or circuit breaker, which keeps people from getting shocked and prevents fires. Specific grounding practices may vary from place to place, however, and continue to evolve as new standards are adopted.

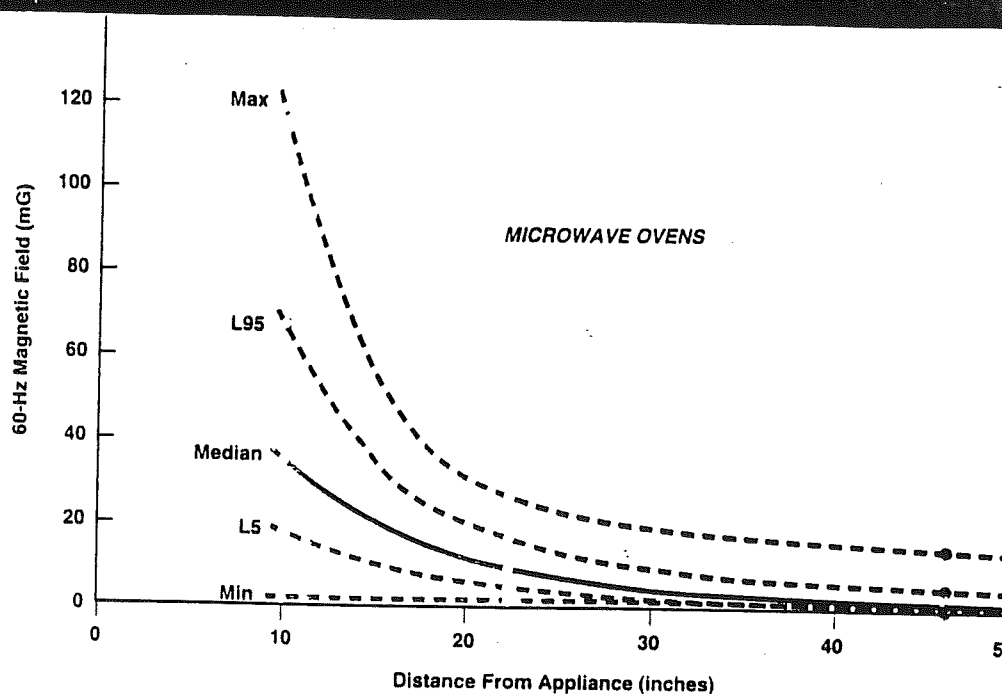
Current practice in the United States, as set by the National Electrical Code, usually involves grounding the neutral wire at the electrical service entrance to a residence by attaching it either to a water pipe or to a long rod driven into the soil. Additional grounding connections may also be made; for example, the shield of a television cable—already grounded at its own service box—might also be attached to a water pipe.

Such multiple connections mean that ground currents can flow on different paths, including water pipes, telephone cables, and cable TV lines. Whereas magnetic fields created by a pair of closely spaced wires (for example, house wiring) tend to cancel each other, those produced by currents on such conductors as water pipes are not canceled. Even a relatively small current flowing on a pipe can be a source of a significant magnetic field in a residence.

* This knob-and-tube type wiring was exposing Lorieta intermittently before her Cancer. It is not now!

FIELDS FROM APPLIANCES

Magnetic fields produced by appliances—such as fields from microwave ovens, shown here—decrease rapidly with distance and vary widely among various models. About 90% of the microwave units in the study produced fields within the range indicated by the lines above and below the median line.



The survey found that in many residences a substantial fraction of the return current flows on water pipes rather than through the neutral wire leading directly to a distribution transformer. It is also not unusual for the ground current in one residence to flow through interconnected water pipes to another residence, creating magnetic fields there.

The survey provided data about the residential distribution of magnetic fields caused by ground currents. Residences with the highest grounding system fields (the top 5%) were categorized, for example, by residence type, age, and location and by the type of distribution lines serving the residence. Observations of actual sources of magnetic fields made during the survey will aid in determining what changes in grounding practice might reduce residential fields. Obviously, safety considerations related to shock and fire cannot be compromised.

In November 1992, EPRI held a workshop at Michigan State University to share information and develop plans related to magnetic field management research and the safety codes regulating residential

grounding. This workshop was attended by utility representatives, safety code panelists, trade union representatives, regulators, and EPRI staff. Any code modifications related to grounding would require consensus among the many parties involved. Individual utilities—and especially customers—are not advised to take action on their own.

One example of how EPRI is helping provide technical information to code makers is work being funded with Empire State Electric Energy Research Corporation to study the mechanism by which ground currents create magnetic fields. This research also entails a review of grounding practices in other countries and their possible effects on magnetic fields. In some countries, for example, an additional wire is carried back to the distribution transformer, where a ground connection is made.

Fields from power lines

Another major thrust of the survey was to determine the relationships between residential magnetic fields and various power line characteristics. For this purpose, 24

types of power lines were identified, including underground distribution cable, various combinations of primary and secondary overhead distribution lines, and transmission lines. The largest median fields were produced by three line types: three-phase primary and secondary lines with separate neutrals, two three-phase primaries and a secondary with a common neutral on the same pole, and transmission lines.

Power line fields were also correlated to residential areas, with the highest median fields found in urban areas and the lowest in rural areas. Among types of residences, apartment buildings and duplexes had the highest median fields; single-family dwellings had the lowest. Median fields also tended to increase with the age of the residence: fields in homes less than 10 years old were about half those in homes more than 50 years old. The reasons for these variations are still being explored.

One problem faced by epidemiologists studying EMF exposure has been to find an appropriate way to codify types of overhead lines near homes to estimate

what magnetic fields may have been present in the past. To help resolve this issue, residences in the 1000-home survey were assigned one of four wire codes according to a method developed by Nancy Wertheimer and Ed Leeper in early epidemiologic studies. (Underground distribution was considered as a separate category.) For example, a residence within 50 feet of a transmission line or three-phase distribution lines with thick primary wires was categorized as having a very high current configuration (VHCC). When the wire code assignments were compared with actual median power line fields and in-home spot measurements collected by the survey teams, the fields corresponding to the VHCC code were indeed substantially higher than those corresponding to the other wire code assignments. Measured fields corresponding to the three lower-current code assignments and underground lines were largely overlapping.

More analysis will be needed before researchers can understand why the associations between health effects and wire

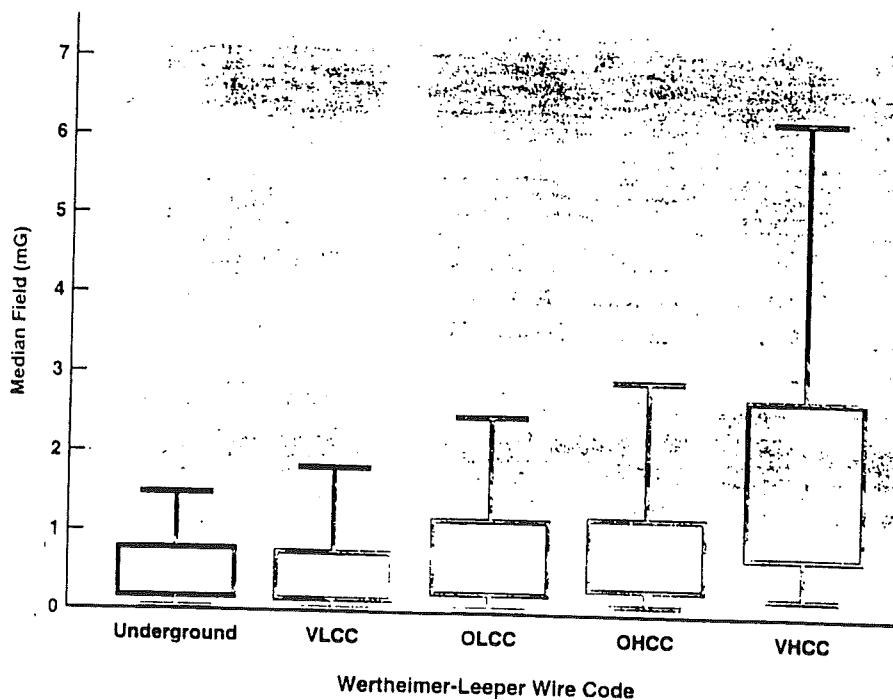
codes in epidemiologic studies have been consistently stronger than the associations between health effects and actual field measurements. Robert Kavet of EPRI's Environment Division is using data from the 1000-home survey to examine possible refinements in the procedure for assigning wire codes. "The Wertheimer-Leeper wire code classifies a home by the highest-ranking source outside," he explains. "We want to expand this classification system to include multiple lines, whose fields could all contribute. This work is now under way, and we expect to have initial results later this year."

Harmonic field characterization

One of the key unknowns in EMF research is what characteristics of fields may be most important in possible health effects. For example, epidemiologists are interested to learn whether standard 60-Hz fields or higher-frequency harmonics may be associated with possible EMF health effects. Harmonic fields are often caused by appliances, especially those controlled by

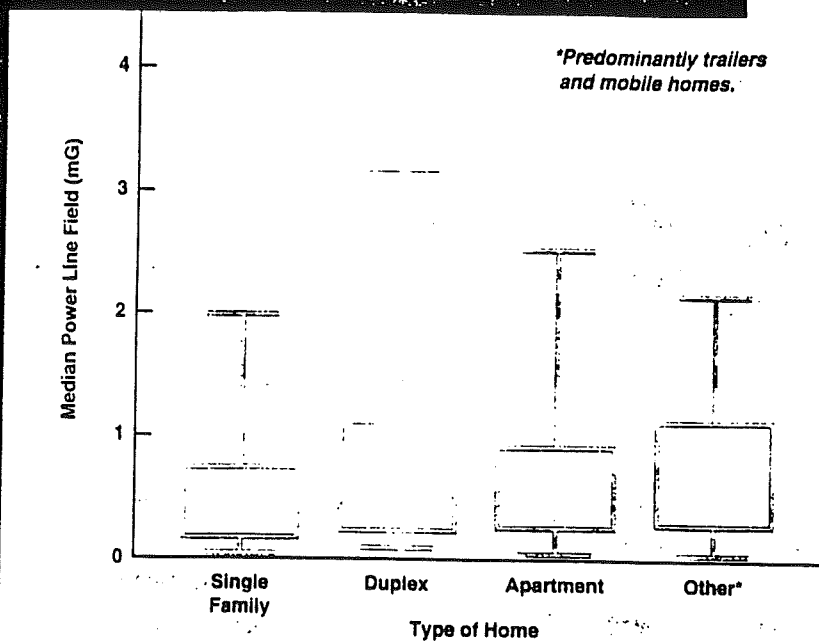
solid-state devices. In preparation nationwide survey, a more elaborate protocol was used at the homes of 10 employees. Although the main purpose of these additional measurements was to validate the protocol to be used in the larger survey, a detailed characterization of harmonic magnetic fields was also conducted.

The more elaborate measurements were made with the MultiWave field measuring system, which was developed by Electric Research and Manufacturing. This system uses multiple sensors to measure magnetic fields simultaneously throughout a residence and relate field strengths to currents in selected wires and ground circuits. MultiWave can also measure field orientation along three axes at each location. Such orientation data can be used to determine the extent to which residential magnetic fields are polarized—the fields are stronger in some directions than in others. For the extended protocol at the employees' homes, MultiWave used 8 to 16 magnetic field probes and

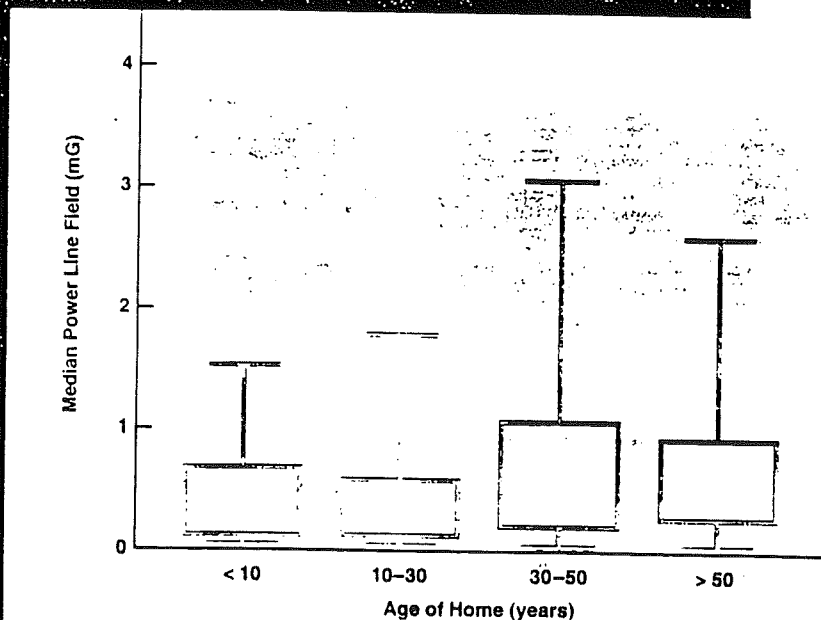


FIELD DISTRIBUTION BY WIRE CODE

One of the most important questions in the study of the possible link between EMF exposure and health effects is the significance of the so-called wire codes, used to estimate residential field strengths by visual inspection of nearby power lines. Spot measurements taken during the survey revealed that homes categorized as having a very high current configuration (VHCC) do generally have higher field strengths than homes in the other wire code categories. However, values for homes in the lower current categories overlap to the extent that the relationship between fields and wire codes is not statistically significant.



RESIDENTIAL VARIATIONS Median values of power line fields differed somewhat according to the type and age of the residence. Single-family houses, for example, had the lowest median fields, and newer homes tended to have lower fields than older homes. While these differences are interesting, researchers have not yet found clear explanations for them.



current probes were deployed at each site and recorded fields of various frequencies for 24 hours.

The harmonic analysis performed on data from the employees' homes showed that the difference between the ordinary 60-Hz field and the total magnetic field including all harmonics was generally less than 1% but could occasionally be as great as 15-20%. The average total harmonic field was 0.1 mG; 10% of harmonic fields were above 0.2 mG. The third harmonic (180 Hz) was by far the strongest component. Measurements with MultiWave also showed that fields in residences were slightly elliptically polarized. While the main goal of the survey was to quantify 60-Hz fields and sources, this information on harmonics and polarization may be valuable if health studies show these factors to have biological significance.

A critical time

Beyond its immediate importance for research in the United States, the 1000-home survey has also set a standard for similar work in other countries. One of EPRI's international affiliates, for example, is currently using information from this project to conduct a survey of its own system. EPRI provided the utility with measurement protocols, instruments, analysis software, sample brochures for the public, training at HVTRC for utility staff, and hot-line support during the survey.

"The data from the 1000-home survey come at a critical time," concludes Karl Stahlkopf. "Public interest has been raised by attention to the issue in the popular media. People want to know what fields they're exposed to, and from which sources. The results of this survey can help guide individual utilities as they respond to customer queries on this subject. In addition, the results provide valuable information for ongoing health studies, quantify the role of ground currents in generating magnetic fields in homes, and help us plan research into various field management options."

Moorhead family suspects electricity for health problems

By Dave Olson
STAFF WRITER

Lynn Sipe doesn't know for sure if electricity in the water pipes of her south Moorhead home is behind her family's health problems.

But her heart tells her something's wrong with the house on the corner of Third Avenue and Fifth Street.

For her, it was heart palpitations. Her doctor advised her to cut out caffeine, and that helped dramatically.

But last summer, Sipe, who works for the Moorhead School District, had the opportunity to stay home during the summer for the first time in more than 10 years.

Within days of the start of her summer break, the palpitations returned with a vengeance.

She did a number of things to try and stop them, including stress reduction. Nothing helped.

At their height, the palpitation attacks were up to 30 an hour.

Sipe planned to go back to the doctor, but before she could, school and work started again. And when it did, her palpitation rate dropped.

She hadn't a clue about what could be wrong. Some friends referred her to Duane Dahlberg, an associate professor at Concordia College.

Dahlberg is a researcher in the field of stray voltage and a firm believer that electricity and electromagnetic fields can affect the way animals and people feel.

Sipe said Dahlberg measured her home for electromagnetic fields last fall and found stray voltage coming in on a water pipe.

Sipe said she has since gathered information about the possible effects of EMF and heart problems, which are said to be typical.

So are allergies.

One of her daughters started developing allergies shortly after the family moved into the home about 15 years ago. When her daughter recently went away for school, the symptoms subsided. When her daughter returned home to stay for a while, the problems began coming back, she said.

Her husband has experienced more subtle problems, such as blurred vision and headaches. Another daughter has asthma.

Sipe said if it ever came to selling the house, she would not do so without warning the potential new owners of what they suspect.

If the water pipe is indeed the problem, Sipe said, there is no way the family can remove the hazard.

"There's nothing that we can do," she said.

Jury Rejects Claim That Power Lines Caused Cancer

By AMY STEVENS

Staff Reporter of THE WALL STREET JOURNAL

SAN DIEGO—In a setback to courtroom attempts to link electrical current and cancer, a jury rejected a couple's claim that power lines over their home caused their young daughter to develop kidney tumors.

The verdict in favor of San Diego Gas & Electric Co., resolved the nation's first jury trial on the issue of whether utilities can be held responsible for illnesses that some researchers say are related to electromagnetic fields. Three years ago, Boeing Co. paid more than \$500,000 to settle a suit by a former employee who claimed that his leukemia was caused by exposure to electromagnetic fields, or EMFs.

In the San Diego Gas case, Ted and Michele Zuidema contended the utility became aware as early as 1986 of potential health hazards from magnetic fields produced by electric current, and was negligent in failing to warn customers. But the jury found there wasn't enough scientific data at the time five-year-old Mallory Zuidema was born, to hold San Diego Gas liable for failure to warn. The panel, which deliberated for only four hours, didn't reach the question of whether power lines actually caused the girl's rare congenital condition.

About a dozen similar personal-injury lawsuits are pending elsewhere in the country. While verdicts don't set legal precedent because they address only the facts in a given case, lawyers who represent utility companies said the San Diego jury's decision is likely to send a message to potential future litigants. "This should discourage plaintiffs' lawyers who think they will have an easy time bringing these cases," said Tom Watson, a Washington lawyer who is defending a number of utilities and makers of electronic devices in other personal-injury EMF suits.

Several population studies have indicated there may be some link between EMFs and various forms of cancer, but none have been conclusive. A spokeswoman for San Diego Gas said the verdict "reinforces what we've said all along, that there is no evidence that power lines caused this little girl's cancer."

Michael Withey, the Zuidemas' lawyer and head of a nationwide group of law firms bringing EMF lawsuits, said the verdict is "not the end of the story," and he plans to pursue other cases. "So much scientific evidence has come in since 1986, the relevant time frame of this case, that we don't see this as a major setback in proving that power lines cause childhood cancer, and in trying to change the power industry's conduct."



Letters

5-22-93

FF

Duane Dahlberg's stray voltage claims are based on non-scientific 'evidence'

Electrical phenomena like stray voltage and electromagnetic fields are a serious concern for all electric utilities, including member-owned electric cooperatives. How important you ask? Last year we supported federal legislation to spend \$65 million researching electromagnetic fields. The utilities, by the way, will pay about half that tab besides the millions already spent on electromagnetic fields.

Concerns about stray voltage are no different. Minnesota's electric cooperatives have responded personally to thousands of requests for investigation. We visit the farms. We measure the voltage. We take whatever steps are necessary to correct the problem — be it our fault or working with the farmer to correct on-farm wiring problems.

Like most any issue, different people have different opinions. We respect that. Indeed, we hope those not sharing our views will help develop solutions to problems confounding some customers receiving electricity.

A scientific approach is critical to resolve stray voltage concerns. Duane Dahlberg's research isn't scientific, it's anecdotal, gleaned from surveys that Concordia College ought to be embarrassed having its good name associated with. These are some of the survey questions Dahlberg used, as reported in the May 6 Forum, that led to his conclusion that "one-third of dairy farms in Minnesota and Wisconsin are affected by stray voltage:"

►Have your cattle exhibited these symptoms: "swollen legs and joints;" "high veterinarian bills;"

"breeding problems;" "poor water consumption," "poor milk production," etc.

►Have you personally experienced these symptoms: "frequent headaches;" "excessive fatigue;" "forgetfulness;" "often feeling under stress;" "vision problems," etc.

►Has your on-farm equipment had "an unusually high rate of battery failure;" "radio and TV set failure;" "noisy telephone requiring frequent service calls or having false rings," etc.

Using this survey, Dahlberg could arrive at the same results for questions involving the poor play of the Minnesota Twins, excessive television watching, broken political promises or anything else. It is an unscientific survey and does not contribute to any meaningful discussion of a very serious issue. Perhaps that is why Dahlberg called a press conference instead of using a scientific peer review or publishing his results in a scientific journal which would invite a critical, but a productive discussion of his findings.

Unfortunately, being an industry spokesman carries negative connotation. We must, some think, have something to hide. We don't. We want to do right by our members, by our customers. Dahlberg doesn't lend anything to collective efforts by industry, by academia, by the federal government, by the dairy industry and by others to resolve this vexing problem of stray voltage.

Mark Glaess

Manager, Minnesota Rural Electric Association
Maple Grove, Minn.

Professor cites stray voltage as possible cause of health problems

MARILYN WHEELER

ASSOCIATED PRESS

Put both feet on the floor. That's right, flat on the floor. Now, what do you feel? Pain? Tingling? Weakness?

Whether you're touching the floor of your home or touching the floor of a dairy barn, a Concordia College physics professor says you're exposed to stray voltage.

Duane Dahlberg was an expert witness in the case of a Ray, N.D., dairy farmer awarded \$429,506 last week for stray voltage harm to his animals.

But Dahlberg is even more concerned about the health problems he believes stray voltage is causing among humans.

"I'm kind of on the outs with utilities and universities for continuing to bring this up," Dahlberg said. "But it's there, and I've got

to do that."

Indeed, he has given other researchers fits since theorizing in 1985 that grounded utility wires were leaking current into the earth.

"Whether it be stray voltage on the dairy farm, electricity from a transmission or distribution line, using an electric blanket or a microwave or sitting too long in front of a video display terminal — all of those seem to produce

sort of a general effect."

Is he some kind of a kook?

"Yes," Dahlberg says. "Except that I'm right."

Jerry Martens, supervisor of specialty testing for Ottertail Power Co, says Dahlberg is dead wrong.

"The good doctor and I are not eye to eye on this, believe you me," Martens says. "I think he confuses stray voltage with other things."

Both men sit on a steering committee created by the Minnesota Environmental Quality Board to review the issue of stray voltage as it relates to the dairy industry.

In 1992, the task force reported that cows on about 11 percent of Minnesota's 15,174 dairy farms had experienced problems with stray voltage in the previous five years.

No one disputes that when a high-voltage wire — even an ex-

tension cord with exposed wires — touches the ground it leaks electrical current.

It's called a ground fault, and Dahlberg says it is one of the first things a utility trouble shooter looks for.

Martens says the utility industry "takes the position that stray voltage does exist in some cases. When you talk current in the earth, that's totally another issue."

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Electricity: Bad for your health?

Professor, speaking at Kiwanis Club Tuesday, says it i

By FRANK RZECZKOWSKI
Staff Writer

Electricity powers the American way of life — it illuminates, it heats, it conveys information — but it may also be harming us, a Minnesota physics professor claims.

"In our world we don't understand the electrical part of the human body," said Duane Dahlberg, a professor at Concordia College in Moorhead, Minn. "We understand the chemical side of it, but we need to know how the body uses and is affected by electricity."

Dahlberg, who spoke to the Minot Kiwanis Club Tuesday, has spent 11 years researching the effects of stray voltage.



Dahlberg

What is it?

Stray voltage is electrical current that escapes from transmission lines or other sources and gets into the ground. Dahlberg and other stray voltage proponents claim the electricity can impair the health of people and animals exposed to it.

Civil suit

In October, he testified in the civil suit of a Ray dairy farmer, who claimed stray voltage was affecting his cows' dairy production.

A jury awarded the farmer more than \$400,000 — the first such verdict ever in North Dakota. The case is currently under appeal.

Dahlberg said dairy farms are vulnerable to stray voltage because of the amount of highly-conductive piping and equipment the cows are exposed to.

Opponents

Understandably, not everyone agrees with Dahlberg's theory — especially utility companies.

And even Dahlberg admits it's difficult to prove scientifically that stray voltage causes damage. Because electricity is so universally used, he said, it's hard to find a control group not exposed to it.

Even more confusing, the strength of the voltage does not appear to be directly related to the effects. Sometimes, Dahlberg said, smaller amounts of electricity can be the most harmful.

He feels he's right

But Dahlberg claims the connection between stray voltage and health problems is at least as strong as the association between smoking and health problems.

"I don't expect everyone to agree with me," he said. "But I feel what we've come up with is right."

OPINION

LETTERS

Clearing up some electric confusion

I feel I must respond to an article printed in the Dec. 1 edition of the Minot Daily News. I was present at the Kiwanis Club meeting at which Professor Dahlberg spoke about electricity and the possible negative effects on human health. I feel some of Professor Dahlberg's comments require clarification. Additionally, the article as printed included some statements that are misleading and not totally accurate.

The statement in the Minot Daily News article stated that "stray voltage is electrical current that escapes from transmission lines or other sources and gets into the ground" is incorrect. Stray voltage is voltage that is going to ground that should be going back on the neutral wire. This occurs when you have a better ground than the neutral, as electricity takes the path of least resistance.

In circumstances where our customers have contacted us with stray voltage concerns, we have found, in most cases, a loose ground wire or missing ground rod. This can usually be corrected with the assistance of a qualified electrician and/or working with the local electrical utility.

Electric and magnetic fields (EMF) on the other hand are entirely different than stray voltage. EMF sur-

rounds any wire that is conducting electricity. The distribution power line serving your neighborhood produces EMF. So do household appliances such as your toaster, hair dryer, lamps and washing machine.

An electric field is created by voltage. The higher the voltage, the greater the electric field. For example, a high-voltage transmission line that brings electricity to a city will recreate a much stronger electric field than your television set produces.

To help us fully understand the effects of electric and magnetic fields, many national research programs have been conducted and many more are in progress. Early research in this area concentrated on possible health effects from electric fields. Most scientists have concluded that electric fields do not pose a threat to human health. Thus far, the studies on magnetic fields have offered such inconsistent results that most scientists and public policy groups are pressing for research. Most scientists agree, however, that if health effects do exist, the risk of illness from magnetic fields is very low.

As I stated, research is underway. New studies are being developed in some of the country's leading universities and scientific laboratories. Each year, in the United States alone, more than \$15 million is spent on research.

The Electric Power Research Institute (EPRI), to which NSP and other major energy companies contribute financial support, the U.S. Department of Energy, the National Institutes of Health and the National Institute of Cancer are all conducting research in this area.

As this research continues, and customers within our service territory have questions about stray voltage and/or electric and magnetic fields, please contact our local office. We are always available to answer questions.

— Bruce J. Kopp
principal manager
Northern States Power Co.
Minot

Commission will seek research funds for solution to stray voltage problem

By Cate Terwilliger
Associated Press

ST. PAUL — Rural Battle Lake dairy farmers who say stray voltage has sickened their herds and threatened their livelihoods said a state commission's ruling offers hope that the issue might be resolved.

After six hours of testimony Friday, the Public Utilities Commission voted to work with the Legislature to secure funding and begin research into the effects of ground current.

"That's a major step forward, for the commission to go out there and ask for funding," said Darrell Franze, 27. "Whether we will still

be in business by the time that type of research is done ... I wouldn't hold my breath. But it might help some farmers down the road."

Despite testimony from the Lake Region Cooperative Electric Association that there's no stray voltage problems on the farms, the commission also ordered the cooperative to continue reducing voltage to the farms.

In March 1993, the PUC ordered the cooperative to reduce voltage to the farms by moving transformer poles and installing blocking devices. The PUC also ordered the cooperative to draft a plan to further reduce voltage.

On Friday, the PUC ordered the

cooperative to implement that plan within 45 days.

Most research has focused on "cow contact voltage," which creates a current through a cow's body from one point — for example, a water cup — to another, like a barn floor. Lonnie Nelson and Franze say that cow-contact voltage isn't a problem on their farms — but electricity injected into the earth through grounding wires is.

"In late December, we dragged six beautiful heifers out of their stalls because they couldn't walk," Franze told the commissioners, his voice quavering.

An angry Nelson, 34, held up photos of a Holstein lying on blood-soaked straw.

Pioneer Press

1-16-94

Farmers still angry over excess voltage despite PUC ruling

CHARLES LASZEWSKI STAFF WRITER

Two Minnesota dairy farmers who have been battling their local electric co-op for two years because their cows keep getting shocked received some help from a state agency Friday.

The Minnesota Public Utilities Commission, which regulates electric companies, ordered the Lake Region Cooperative Electric Association to take more steps to reduce the volts of electricity flowing through the Battle Lake farms of Darrel and Marnie Franze, and Lonnie and Renee Nelson.

The co-op also must follow up with tests to see if the steps are working.

VOLTAGE CONTINUED ON 2D ▶

VOLTAGE

▼ CONTINUED FROM 1D

But for the beleaguered farmers, who described how their cows have been dying, aborting and crumbling to the barn floor in pain, Friday's action was not enough.

Darrel Franze said they may file a lawsuit to force the co-op to change the way it does business.

"This went against Lake Region, which wanted to drop the whole thing, but it was not necessarily for us," said Renee Nelson of the commission's action.

The problem is that the steps the commission ordered are better for dealing with major stray voltage problems — the kind that result when electricity returning to a substation on the neutral line meets resistance and backs up into a barn and gives cows a noticeable shock when it they rub up against something metallic.

Nelson and Franze are convinced they are battling a "silent monster." In their view, they believe the stray voltage exists because only about 10 percent of the electricity reaches the substation on the neutral line while about 60 percent flows through the ground. Because of this, it gets into the barn and flows through cows without them a noticeable shock. The farmers and their sons say, the stray voltage makes animals edgy and unable to drink, or produce as much milk, and eventually it kills them.

The farmers want to force the co-op to add a much larger line onto its power pole so that electricity will return through the line rather than through the ground.

Oscar Sorlie, Jr., the representative of the co-op, says the company believes it has the best care of the farm problem and stalling additional equipment called isolators.

While the commission is critical of the co-op for investigating the possibility of stray voltage through the ground, commission chairman Dona pointed out that there was no scientific research to prove that electricity could harm animals.

Waubun man calls meeting on stray voltage

By TIM KJOS
Staff Writer

Stray voltage is a well-documented problem on Minnesota dairy farms for more than a decade, yet the problem persists.

Several west central producers aired their problems at an informational meeting in Detroit Lakes March 22 in hopes corrective solutions may be in the offing.

Meeting organizer Tom Revier, Waubun, said he and other farmers

are "battling" the electric utilities in efforts to solve the mystery, but oftentimes nothing happens.

He hopes to convince state lawmakers to become more involved.

"We have a dairy farm near Waubun and we have a stray voltage

problem," commented Revier. "It can be frustrating. If only you could see electricity, but you can't."

The meeting was intended to provide farmers in similar predicaments

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Voltage

Continued from page 1A

ments with pertinent information. Revier also wants producers to join together "to work at solving this problem with more force behind us."

Stray voltage is blamed for a number of problems on dairy farms: abortions, birth defects, swollen joints, rapid weight loss after calving, lapping at water, kicking when milked or touched, increased mastitis and death.

Farmers also say stray voltage causes health problems for themselves and their families.

Several farmers speaking that afternoon, including Revier, feel they have been abandoned by University of Minnesota scientists who don't think stray voltage is a serious matter.

Concordia College physicist Duane Dahlberg has been studying the problem for 11 years, visiting dairy farmers throughout the United States and writing research papers. He initially thought stray voltage could be cured in two years.

"We can solve the problems, figure out what is going on in the dairy barn, but getting state agencies to listen is the trouble," pointed out Dahlberg.

He also blamed electrical utilities for saying that if stray voltage falls below a certain measurement the resulting effect is minimal or negligible.

"The problem is the cattle will determine whether or not there is a stray voltage problem," maintained Dahlberg.

He said scientists have yet to devise a means of measuring the correlation between stray voltage and the resulting effects. However, Dahlberg says farmers see what is happening in their barns.

Dahlberg said part of the stray voltage problem rests with the current method of transmission. Because of the grounding system, Dahlberg contends that two-thirds of



Waubun dairy farmer Tom Revier was among those producers telling of their stray voltage problems last Tuesday in Detroit Lakes.

the electricity is returned to the substation through the ground, rather than on the neutral transmission lines.

As such, Dahlberg says even Amish dairy farms in the United States and Canada, which don't use electricity, experience stray voltage.

Darrell Franze, Battle Lake, had a rolling herd average in 1988 of over 20,000 pounds. Nine months later, it had dropped to 17,000 pounds and cows were dying. He says between 150 and 200 head have died since then.

Franze attributes the production and death losses to stray voltage.

He has since tried a number of methods to prevent the problem, but nothing seems to help, other than cutting the primary ground.

Two years ago, he and Clithrell dairy farmer Lonnie Nelson filed a complaint against their electrical cooperative in order to solve the problems on their farm. The complaint is still pending.

Both men say they have documented proof that electricity is entering their dairy barns even when the power is completely turned off on their farms.

Using a sensitive meter, Franze said the electricity increased from one-half milliampere when the power was turned off to 2.5 milliamperes when it was on.

The same test on Nelson's farm found over 1,500 milliamperes at the peak, including 4.5 volts coming through the barn floor.

"There is nothing on the farm that can draw that much electricity," contends Nelson.

He blames the sudden increase in voltage on the opening and closing of the substation capacitors.

Nelson said the utility put in ground rods near his farm to correct the stray voltage problem, but it only seemed to worsen it. Within a couple days, four cows confirmed pregnant absorbed their fetuses, one heifer died, cows stood sideways in their tie stalls and his wife, then five months pregnant, nearly aborted.

He said isolators can help to alleviate some stray voltage problems, but not all of it.

"If the utilities would start listening to us and see what happens, then they'd know, but we're just dumb farmers and don't what know we're doing," criticized Nelson.



Investigating stray voltage

How one power company helps farmers

BY SHANNON LINDEROTH

Finding causes of stray voltage instead of finding blame.

A stray voltage diagnosis is enough to make anyone queasy, given the highly publicized history of legal battles pitting farmers against utilities or milking equipment companies. But running for cover or shifting blame from one defendant to another hasn't eliminated the problem.

The issue of stray voltage hasn't gone away, nor will it, unless the cause of the problem is found. A fledgling Consumers Power Company program, aggressively recruiting dairy farmers with suspected stray voltage problems, is attempting to do just that. The utility serves over half of the dairy farms in Michigan.

It's using an advertising blitz and special toll-free telephone number to identify potential testing sites.

"We'll work with customers until the customer is satisfied and stray voltage is no longer a concern," says Jim Schrandt, Consumers Power Company power quality director.

The utility has expanded its on-farm investigation services to find out from where the stray voltage problems are stemming.

"We want farmers to be glad we've been there," says Dick Thompson, Consumers Power Company power quality specialist. "We want to solve the problem. We're providing an on-farm engineering service and we're here to deliver results."

Six field investigators travel the state, responding to customer investigation requests. Thompson reports that investigators have been "swamped" since the initiative began.

Once the utility receives the farmer's request, a Consumers Power Company representative calls the customer to confirm the

request. Then the case is given to a field investigator, who visits the farm to determine the scope of the problem and to offer solutions.

On a typical farm visit, Thompson begins by checking out the farm's electrical system. Pulling out rubber boots, a hard hat, and various voltage-measuring devices from the rear of his truck, Thompson begins searching for causes of neutral to earth voltage (NEV), or stray voltage.

Finding the cause is usually a process of elimination. That and the experience of knowing what to look for. Thompson adds that problems usually arise from a combination of factors affecting the farm's electrical system and the power company's system. Just one system or the other is seldom to blame. "Most times it's a partnership," he says. "This is really impor-

tant for people to know."

Investigations follow a logic: progression of steps. At this particular farm, Thompson takes readings from the overhead power line between the house and the barn. Then he had the farmer momentarily shut off power to the entire farm. This confirmed his interpretation that the cause was somewhere on the farm. Keep in mind that this single system source of NEV is often not the case--both systems are usually at fault.

Voltage measurements throughout the barn revealed a steady 1-volt to 2-volt reading with several disturbing spikes up to 6.7 volts. Cattle generally begin responding to NEV at 1-volt and above.

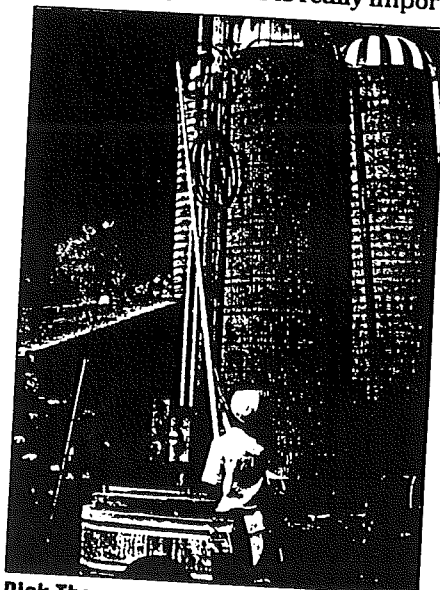
The pattern of relatively low voltage with several spikes continues when power to the barn was shut off and power to the house remained on. "It's probably something in the house," Thompson says, making a notation on his call-sheet.

Thompson also makes a visual evaluation of cattle on farms he visits. "Hair coat, feet, and leg will give an indication of problems," he notes.

A couple of hours and a battery of tests later, the electrical exploration showed the culprit to be an undersized overhead wire with bad connections. "A new wire should solve most of the problem," says Thompson.

He further suggested rewiring the well pump from 120-volt to 240-volt because every time it started, it caused the huge voltage jump in the barn.

Thompson made some more notations on his call-sheet, then loaded his gear, retrieved his county map from the seat to find the next farm on his list, and headed out of the driveway to begin the process all over again. □



Dick Thompson, Consumers Power Company power quality specialist, begins his investigation of stray voltage on this farm by measuring the voltage on overhead power lines.

Survey finds 'relationship' between voltage, farmer health

Moorhead, Minn.

A survey completed by two Concordia College professors of more than 350 Minnesota dairy operators has reached the conclusion that there is a statistically significant relationship between stray voltage on dairy farms and the health of the farms' operators.

The survey was conducted by Duane Dahlberg, a Concordia professor of physics and former chairman of the Minnesota Pollution Control Agency board, and Laurence Falk of Concordia's sociology department.

Mr. Dahlberg and Mr. Falk received assistance in conducting the survey from the Minnesota Department of Public Service and the Minnesota Environmental Quality Board, according to officials of those agencies.

"In this study we tried to see if there was a statistical correlation between human health issues, animal health, and electrical machinery problems on dairy farms," Mr. Dahlberg said.

The farms surveyed by Mr. Dahlberg and Mr. Falk were farms they believed may have had stray-voltage problems. The addresses were obtained at meetings they have held on stray voltage across the state over a decade. Whether or not a farm had a stray-voltage problem was determined by farmers' responses to the questionnaire.

"We found that as the number of animal health problems on farms with stray voltage increased, so did the number of health problems and electrical machinery problems," Mr. Dahlberg said.

The researchers' questions regarding human health were

obtained from problems farmers has told them about over the years. Some of the 24 human health questions asked if respondents had

- Tingling or numbness in arms or legs
- Vision problems.
- Excessive fatigue.
- Menstrual problems.
- Unexplained nausea.

"Farmers in Minnesota and across the country had been telling me that their health problems were related to their stray-voltage and animal health problems for years. We wanted to see if there was a significant statistical relationship," Mr. Dahlberg said. Although the survey was only of Minnesota farmers, Mr. Dahlberg claims that Wisconsin farmers in particular have complained of a high level of neurological problems associated with

stray voltage.

"The health problems in Wisconsin are almost unbelievable," he said.

The statistical relationship that exists between human and animal health problems on farms claiming they have stray voltage is beyond the realm of chance, the researcher said. Mr. Dahlberg and Mr. Falk found this relationship using statistical analysis methods that have been reviewed and accepted by Mr. Falk's colleagues on a national level.

Mr. Dahlberg's methods have not been peer reviewed by other physicists and that is causing some criticism of the survey. Peer review by other scientists is the method by which scientific work is validated.

"They simply asked farmers to record their perceptions. This was a subjective survey. A more careful survey would need to be done," said Christopher T. Davis of the Minnesota Department of Public Service.

Although Mr. Dahlberg said he cannot name the state agency that mailed the questionnaires around Christmas 1992 because of the agency's wishes and the political volatility of the issue, Mr. Davis acknowledged that the DPS made the mailing. The envelope containing the questionnaire did not have a DPS return address.

Why the anonymous spending of tax dollars?

"Our commissioner thought supporting the survey would fur-

ther the debate on stray voltage but we didn't want to endorse it by putting our name on it," Mr. Davis said.

The agency is shelving the study and has no plans to do the more careful study that Mr. Davis asserts is necessary to establish an objective link between stray voltage and the health of animals and humans.

"Health department officials told me a study that didn't have the bias of this study would cost over \$100,000," Mr. Davis said.

Daniel Foley, medical director of United Children's Hospital and a former Pollution Control Agency board member during the time Mr. Dahlberg was chairman, sees the issue from both sides.

"There's an element of truth in what Duane is saying but we have to have proof because the magnitude of what he is saying is immense. We live on electrons. I've told Duane he needs peer review," Dr. Foley said.

However, Mr. Dahlberg said "peer review is old boys' club. It's run by people working in the field and if they disagree with you it's very difficult. When you break new ground there's nobody to peer review it. I've found there is a lot of support among scientists for my work but they are unable to do anything because of fear for their jobs."

Linda King, executive director of the Environmental Health Network in Chesapeake, Va., agrees with Mr. Dahlberg. She

said her organization has worked with people and communities across the United States who suffer from health problems caused by environmental pollution.

"This has happened over and over again. Science is never up to date with what people automatically know about their own health. Common sense is more valuable than anything else," Ms. King said.

Ms. King asserts that peer review can be the equivalent of foot dragging and that it doesn't take a committee of rocket scientists to find out if people are getting sick from a particular cause.

"People don't want to get sick. They want their children to be healthy. Even if there isn't a absolute scientific proof we need to err on the side of public health. Failure to do so causes immense suffering and costs society more in the long run," she said.

For his part Mr. Dahlberg is standing by the validity of the survey.

"We had heard about terrible health problems from stray voltage for years. The value of this study is it quantifies what people had been telling us. People's observations have value and they must be taken seriously," he said.

Mr. Falk and Mr. Dahlberg will present a paper on portions of their survey to a national association of sociologists soon.

-- Tim King,
special contributor

Legislature trying to hammer out stray voltage law

By TIM KING

The Land Correspondent

ST. PAUL — In a move from politics as usual a Minnesota Senator has brought the principle combatants in the stray voltage dispute to the table to discuss their differences.

Senator Dallas Sams (DFL-Staples), a second term member of the Senate Agriculture Committee and former dairy farmer, was assigned the task of coming up with a resolution to the stray voltage problem by Agriculture Committee Chair Joseph Bertram earlier in the year.

Early in this legislative session, Sams introduced a bill to address a type of stray voltage that has recently come to be called ground current.

At the time the bill was introduced, Sams envisioned it being altered by language resulting from a mediation agreement between farmers and utilities. The bill is currently waiting to be heard by the finance committee.

Sams is working with the State Mediators Office to assist the parties in reaching an agreement on ground current.

Ground current, farmers claim, is grounded electricity traveling back to the utility from the distribution system.

The current, farmers claim, travels through their barns, livestock, and the farmers themselves causing physical distress and illness.

"The legislature has pretty well addressed the issue of cow contact stray voltage where the cow gets a shock when it touches something," Sams said.

"What we're dealing with now is this concept of ground current going back to the distribution center. This bill would put a lot of money into creating a research team to study a number of aspects of ground voltage.

"From what I've learned, it looks to me like there is some current in the earth that is traveling the path of least resistance. We need to look more closely at it and figure out how to correct it."

In mid-March, an agreement was reached that was

acceptable to both parties. It included the following components:

- ▶ Establish a science advisory task force to review literature on ground current voltage, recommend research strategies, and make policy recommendations following the research.

- ▶ Allocate \$655,000 for the task force.

- ▶ The task force will be appointed by the Minnesota Public Utilities Commission. No utility or farmer representatives will be allowed on the task force.

- ▶ \$95,000 for TERF, a farmer research organization, to collect its existing research data and present it to the team.

- ▶ Establish a Stray Voltage Assessment Team (SVAT) to respond to stray voltage problems not being resolved to normal mitigation procedures.

"Our objective was to get a process everyone can trust by establishing an independent investigative body," Will Caul, a representative for the utilities mediation team, said.

Following the end of mediation, neither side was saying things were perfect.

"In mediation, we've found there are two directly opposite views. Many of these issues just can't be compromised. We can't compromise on the issue of human health," David Lusty, a member of the farmer team, said.

Lusty, who is a long time stray voltage activist and president of The Electromagnetic Research Foundation, is particularly concerned about the failure to agree on anything more than a search of existing literature.

"The utilities really don't want research on ground currents. They'll put this team together, do a literature search, and then



Sen. Dallas Sams

decide if they want actual research. There's never going to be agreement on what the literature says. We'll just keep messing around and people will keep suffering. We wanted to begin research right away," Lusty said.

"We wanted a literature review first and then a recommendation for research. We aren't conceding that ground current is a valid theory yet," Caul said.

The mediated agreement is that the task force has to report back by the start of 1995 on the literature review.

The farmers also have a problem with the SVAT.

"In Wisconsin, the utilities took the SVAT over and they kicked the one farmer off of it. Now they are in trouble with the courts. It doesn't work," Lusty said.

Caul agreed that the Wisconsin SVAT wasn't perfect but claimed it would bring results quicker than a long, drawn out PUC complaint process.

The end result of the differences between the farmers and the utilities was a mediated agreement that was taken to Sams' office by the State Mediator Roger Williams.

Sams, Williams, and senate aides were to then revise Sams' existing bill for hearings in the Senate Agriculture Committee.

When the bill reached the committee, things went down hill fast, according to Lusty.

"These doggone legislators who don't know anything about stray voltage took our mediation agreement and changed it around so we don't even know what we've got. They didn't show any respect for our work. Sams had a pretty decent bill put together, but they changed it around," Lusty said.

Lusty and the farmers who worked for the agreement are bitter. They anticipate spending the rest of the spring attending committee hearings, just so they can hang on to portions of what they thought they had.

Sams maintains that using mediation to work on the stray voltage problem is valuable.

"There hasn't been a lot of trust or communication between these people. Bringing them together at the table may help that. I'd like to see mediation continue between these two groups," he said.



Fried Green Cows

Electrical voltage pollution and the health of U.S. farms

By Tim King

A design feature of the nation's electrical distribution system is wreaking havoc on the lives of midwestern dairy farmers. When Lake Region Electrical Cooperative of Battle Lake, Minnesota switched on a distribution substation following routine maintenance work on June 15, 1992, dairy operators Sarah and Lonnie Nelson were doing chores in the barn. The substation is ten miles from the Nelson farm. Sarah was five months pregnant.

"The cows went crazy. Sarah felt really sick and then went into labor a few hours later," Lonnie Nelson said.

The Nelson's rushed to the hospital. Sarah's premature labor was halted. Their daughter was born full term and was healthy. The cows and their calves weren't so lucky. They aborted a few hours after the electric company turned the substation on.

The Nelson's are among a nationwide group of farmers, and an occasional researcher, that allege that a flaw in the nation's electrical distribution system is jeopardizing their health, their cow's health, and their economic survival. They are insisting changes be made in the distribution system that will protect their lives and livelihoods. The utilities are stonewalling. If the changes do come, the industry may be changed dramatically.

In the past year the Nelson's have had seven cows die because of the problem, which some call stray voltage. They've had to remove 11 cows from their herd because of severe health problems such as skin ulcers and infected udders.

"Electricity came across the floor of the barn and blew a whole in one cow's belly. She bled to death," Lonnie Nelson said.

Darrell Franze has modified his barn cleaner so it can drag dead cows out of the barn. The 27-year-old

dairy farmer, who is a neighbor of the Nelson's, uses it for that purpose quite often. It is routine for his cows to drop dead from the stresses of stray voltage, according to Franze.

When Franze, who is a big strong man, works in his barn for a few hours his legs ache and he is exhausted. He doesn't experience this level of exhaustion anywhere else on the farm. Franze's children won't come into the barn because it makes their legs hurt.

"After I work in the barn it's hard to get my work done in the fields, I'm so tired," Franze said.

Franze, Nelson, and others claim that the method of using the earth to ground the electrical distribution system is creating a form of electrical pollution that the utilities, most scientists, and government regulators refuse to admit exists.

At each farm along a power line, there is a transmission pole with a transformer. The transformer converts electricity from the distribution wires into usable electricity for the farm. There is a utility ground wire running into the earth at each transformer. This wire is often called the primary neutral.

The transformed electricity enters the farm electrical system. Farms which have become highly electrified in the last few decades, have one or more grounding wires in the earth. The national electrical code requires them. The farm ground wires are often called secondary neutrals.

All the electrons that leave the substation have to find their way back. There is a neutral wire that should do that but it doesn't because of the system design. The normal practice is for the utility neutral to be connected with the neutral on the farm. Normally, when the two systems are connected, about 40 percent of the electricity on the primary neutral goes into the ground and back to the substation and so that electricity goes all over the farm," Duane Dahlberg, a physics profes-

sor from Concordia College in Moorhead, Minnesota, said.

Dahlberg and the dairy operators claim that the grounded electricity from the utility travels through the earth. In seeking the path of least resistance back to substations it travels through the farm. It travels through barn floors, through the bodies of cows and humans, into the farm electrical system, and finally back to the substation.

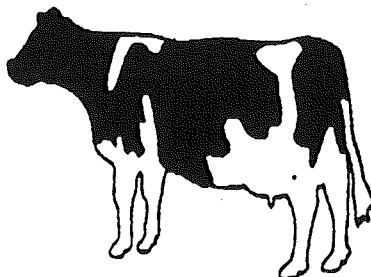
Research on stray voltage and its effects on dairy cattle has not looked at the phenomenon of current traveling through the earth. Study to date has been extensive but narrowly focused on cow contact points.

Cow contact points are two electrical conducting points, a water line and a metal bar, for instance, that could conduct electricity and a cow could be shocked by. Researchers have acknowledged that there is a low voltage stray electricity of this nature running through the barns of some farmers. They have, in most cases, blamed it on inadequate farm wiring. Utilities have responded by hiring electricians who travel for free to farms that have complained about stray voltage. The utility electricians, using accepted electrical theory, usually recommend changes in the farm's wiring.

The tinkering with farm system wiring has solved many stray voltage problems. It has also left many, like Franze's and Nelson's, unsolved. Farmers like Franze and Nelson are told they are bad managers, that the problem is in their farming system, not the electrical system the utilities and university specialists tell them.

Franze and Nelson have had more than they can take. In November 1992 they filed a complaint against Lake Region Cooperative with the Minnesota Public Utilities Commission (PUC). The PUC regulates electrical utilities in Minnesota. Their petition was supported with signatures from nearly 100 other Minnesota dairy operators. The petition was the first of its kind ever filed. Although the farmers have received little relief as a result of their year and a half old petition, there have been minor victories. The PUC has consistently refused to dismiss the complaint, as requested by attorneys for Lake Region and, following a series of PUC tests at the farms, has told the utility it must implement a voltage reduction program on the farms. The program includes moving the utility ground off of both farms.

The PUC does not accept the scientific validity of the farmers' earth born electricity theory, however. "Before the commission can act it must have intellectual and scientific support of the cause," PUC Chair Dom Storm told Franze and Nelson at a hearing January 14 of this year.



The farmers believe they have proved their theory. Between April 24 and May 13, 1993, Franze clipped all the power company's primary ground wires that were on poles on his farm, probably risking his life when he did it. Before he clipped the ground wires his cows were drinking 15-17 gallons of water per day. When he clipped the first primary ground, water consumption increased on average three gallons per cow per day. When he clipped the second one, consumption went to an average of 27 gallons per day per cow. By the time all four grounds were cut, the consumption was averaging 29 gallons.

Water consumption stayed at that level until Lake Region reconnected the primary grounds in early July. At that time it dropped back to 17 gallons per day and has remained there since.

Franze feels that the water consumption monitoring is proof that the electrical field from the power company's primary neutral ground is causing problems on his farm. The low water consumption is a symptom of stray voltage that is keeping his herd under constant stress. The stress leads to low production and eventually high mortality among his cows, according to Franze.

"We don't need to listen to the theories of the scientists and bureaucrats. When we listen to our cows and our bodies we know what the truth is," Stephen Hegge, a Minnesota farmer who lost his farm because of stray voltage, said. Hegge is the lead farmer in a lawsuit against numerous utilities. The multi-million dollar suit alleges that the utilities distribution system has irreparably harmed hundreds of farmers.

Like Hegge, David Lusty has lost a farm to stray voltage. He moved his family to Miltona, Minnesota in the early 1960s. He wanted to try dairying again, without stray voltage. Instead he has been in a decade long battle with his utility, Ottertail Power, to correct the stray voltage problems on his farm.

In an effort to fight back, Lusty founded the Electromagnetic Research Foundation. TERF is a loosely organized farmer based research group that conducts on the farm research with the help of veterinarians and physicist Dahlberg.

Lusty has also severed the primary neutral wires at his farm. Two weeks prior to the power company hooking them back up, Lusty had veterinarian Dr. Dan Hartsell take blood tests on his herd. Two weeks following the reconnection of the primaries, blood was drawn again. "What I found in most of the cows was a large differential in white blood cells. That indicated that the cows were under stress after the primary was reconnected," Hartsell said.

After Lusty's primary was reconnected, Hartsell also noted an increase in sores, swelling at the hock joints, and raw areas where the cows were constantly rubbing. "David Lusty has an electrical problem on his farm. He is an excellent manager who has tried many ways to solve this problem. This is not related to bad management," the Alexandria, Minnesota veterinarian said.

Funding for research on the theory of earth conducted stray voltage has been sparse to non-existent. A recent study of 369 farms conducted by Duane Dahlberg and Concordia College sociologist Lawrence Falk did receive some assistance from the Minnesota Department of Public Services (DPS). "In the study we tried to see if there was a statistical correlation between human health issues, animal health, and electrical machinery problems on dairy farms," Dahlberg said. Stray voltage and human health problems have a clear statistical relationship, the study found.

"We found that as the number of animal health problems on farms with stray voltage increased, so did the number of human health problems and electrical machinery problems," he said.

Dahlberg and Falk's questions regarding human health were obtained from problems farmers had told them about over the years. Some of the 24 human health questions asked if respondents had tingling or numbness in arms or legs, vision problems, excessive fatigue, menstrual problems, unexplained nausea.

"Farmers in Minnesota and across the country had been telling me that their health problems were related to their stray voltage and animal health problems for years. We wanted to see if there was a significant statistical relationship," Dahlberg said.

The study is being criticized by the agency that helped fund it because the information was obtained from farmers and was anecdotal. Although Falk's work as a sociologist has been peer reviewed, Dahlberg's work has not been peer reviewed. "They simply asked farmers to record their perceptions. This was a subjective survey. A more careful peer reviewed survey would need to be done," Christopher Davis of the DPS said.

The agency is shelving the study and has no plans to do the more careful study that Davis asserts is necessary to establish an objective link between stray voltage and the health of animals and humans. "Health Department officials told me a study that didn't have the bias of this study would cost over \$100,000," Davis said.

For his part, Dahlberg is standing by the validity of the survey. "We had heard about terrible health prob-

lems from stray voltage for years. The value of the study is it quantifies what people have been telling us. People's observations have value and they must be taken seriously," he said.

Linda King, the Executive Director for the Environmental Health Network in Chesapeake, Virginia, agrees with Dahlberg. King's organization has worked with people in communities across the U.S. who suffer health problems caused by environmental pollution. "This has happened over and over again. Science is never up to date with what people automatically know about their own health. Common sense is more valuable than anything else," King said.

King asserts that peer review can be the equivalent of foot dragging and that it doesn't take a committee of scientists to find out if people are getting sick from a particular cause. "People don't want to get sick. They want their children to be healthy. Even if there isn't absolute scientific proof we need to err on the side of public health. Failure to do so causes immense suffering and costs society in the long run," she said.

Even though bureaucrats and scientists are stonewalling some legislators are responding to the heat from the farmers and TERF.

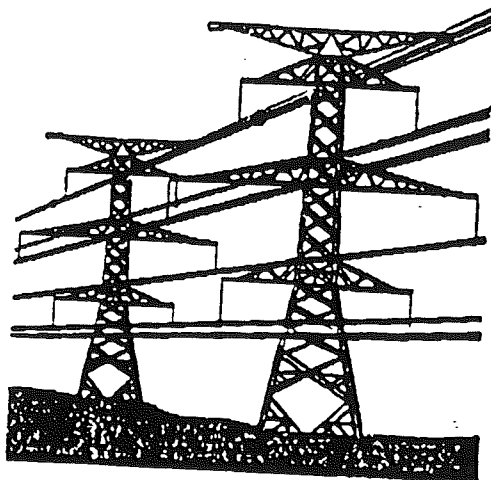
Second term Minnesota Senator Dallas Sams, a member of the Senate Agriculture Committee, has been appointed to a newly created subcommittee on stray voltage. "I'm working with the utilities and the farmers to get them to design a solution they both agree on," Sams, who used to operate a dairy, said.

Sams has also introduced legislation requiring the PUC to examine the extent to which the earth is used as an electrical conductor. If studies determine that using the earth as a conductor causes more harm than good, Sams' legislation will require utilities to discontinue the practice.

"The utilities are really upset with me. They say I'm asking them to redesign their distribution system. I'm not. I'm saying that if the distribution system is causing the harm these farmers say it is, then the utilities have to change their ways. They've always denied the farms had an electrical problem caused by the utilities," Sams said.

The issue is really one of who has the most political power. "These issues are always drawn between the ones who are making the money off the ones being hurt," Linda King of EHN said. "People need to organize to solve their problems."

Z



Farmers, utilities disagree on results of voltage tests

By TIM KING
The Land Correspondent

ALEXANDRIA — The only agreement between farmers and electrical utilities on the results of extensive stray voltage testing that there is complete disagreement.

The unprecedented month-long tests were conducted by the Minnesota Environmental Quality Board (EQB) at the David Lusty farm last spring.

One aspect of the tests was to determine if the Lusty farm, near Milota in Douglas County, was being affected by stray voltage traveling through the ground.

The study also was intended to see if a cow's production increases when farmers cut the utilities primary grounding wire. Lusty, among others, was doing just that.

It took the state, the farmers and the utilities a year to go over the massive amounts of data generated by the videos, electrical data, blood tests, production water consumption records and observations by a veterinarian.

The EQB's Stray Voltage Task Force met in Alexandria in late April to discuss the findings.

"Otter Tail Power has repeatedly been accused of contributing to severe stray

voltage problems. We believe that the report shows no problem and no indication that cutting the ground matters. I ask that the EQB issue a final report showing that the evidence shows no problem," said Kati Sasseeville, attorney for Otter Tail Power, Lusty's utility.

Lusty, president of the farmer stray voltage organization, The Electromagnetic Research Foundation (TERF), and Duane Dahlberg, a Concordia College physics professor in Moorhead, were not convinced.

"There were puzzling amounts of current going into the earth during the test. They were abnormally low during the test, around 20 to 30 milliamperes, as compared to pre- and post-test levels between 100 and 200 milliamperes," Dahlberg said.

Lusty was blunt on

that point.

"The electrical distribution system was manipulated to assure low amperage during the test period. I feel there was playing around with state funds on the test," Lusty said.

TERF members have repeatedly accused utilities of manipulating power levels during stray voltage studies.

"That manipulation of the system is

See STRAY, pg. 5



David Lusty

State takes the middle ground in voltage debate

THE LAND Friday, June 10, 1994—Page 5

STRAY, from pg. 1

going on all the time during tests. It went from 7 volts to 1 volt when the state conducted tests at my farm," TERF member Lonnie Nelson told the steering committee. Nelson's utility is Lake Region Cooperative.

"I wish they could tell us how that's done. We just don't know how to manipulate the system like that," Jerry Hartens, a supervisor in stray voltage testing for Otter Tail Power, countered.

Electrical monitoring equipment at the farm recorded that earth current levels were highest late at night.

"There is no equipment operating on the farm during that period. We need to know where that electricity is coming from. We need to know why there were many variations," Dahlberg said.

The EQB and Dahlberg are particularly concerned about an entire two-day increase in voltage during the middle of a test.

"We need to study that phenomenon more," said Riley Hendrickson, EQB contract electrical technician.

"We wanted to disconnect the ground for two weeks. They only gave us two periods of six days each."

-- David Lusty

Dan Mairs, an electrical engineer for Runestone Electric in Alexandria, reviewed the electrical testing data for the utilities. He said that the ground current fluctuations had no relationship to disconnecting and reconnecting the utility ground wire.

A veterinarian hired by the utilities told the task force that the abrasions on Lusty's cows were normal for stanchion barns. He also said that a stressed immune system detected in blood tests could have been the result of being

confined to a stanchion barn or laying down on cement with minimal bedding.

Lusty claimed that the failure of cows to respond with increases in water consumption and herd health when the utility ground was disconnected was because the disconnection period was too short.

Previous farmer-run tests had shown that cows respond to longer periods of disconnection of the utility ground by increasing water consumption, production and stress.

"We wanted to disconnect the ground for two weeks. They only gave us two

periods of six days each," Lusty said.

With the farmers and the utilities talking to each other on either side of a vast canyon, the state took the middle ground.

Hendrickson noted that some of the test data weakly supported the idea that disconnecting the grounds improved the cows' environment. His scoring system also suggested that some of the data weakly disproved the idea.

Hendrickson appeared to support further study.

It is study that the farmers badly want and, thanks to action passed by the Minnesota legislature this spring, they will get.

It is not clear, however, that anyone will ever agree on the meaning of the results of further testing.

Alzheimer's, Car Crashes Linked, Study Suggests

NEWSDAY

Subtle, undetected cognitive changes in the brains of older people could mean trouble on the highway, study results presented at an international meeting on Alzheimer's disease indicate.

The study, presented by scientists at the Karolinska Institute in Stockholm, found that among 40 drivers over 65 who died in car accidents, two-thirds had classic signs of Alzheimer's — senile plaques and tangles of nerve cells in the brain — that had not been diagnosed before the autopsy. Even such mild forms of the disorienting disease could be a major contributor to car accidents, the researchers said.

In another study reported at the International Conference on Alzheimer's Disease and Related Disorders in Minneapolis, researchers said they are finding that frequent use of sewing machines and other electrical appliances, which emit high levels of electromagnetic radiation, appear to put people at risk.

Eugene Sobel and colleagues at the

University of Southern California conducted three studies analyzing the occupations of people with Alzheimer's. They repeatedly found that dressmakers and tailors were three times more likely to have Alzheimer's than people who did not work in such close proximity to electrical devices.

Four million Americans suffer from Alzheimer's, a degenerative disease that robs people's memory and eventually their ability to carry out simple tasks. No one knows what causes the disease or how to cure it. But the accumulating evidence is pointing to many ways that people can get the disease.

Researchers at the University of Washington in Seattle and the University of Minnesota, for instance, have evidence that a person's brain size may be linked to cognitive deficits, even dementia later in life. They studied 1,500 people over age 65 and found that those with smaller heads were 16 times more likely to show signs of dementia than those with larger heads.

Electromagnetic Fields Linked to Alzheimer's

THE LOS ANGELES TIMES

Electromagnetic fields, previously implicated in triggering leukemia, brain tumors and breast cancer, may play a far more important role in Alzheimer's disease, a University of Southern California researcher will report today.

Results from two new studies conducted in Finland and one in the United States indicate that people with a high occupational exposure to EMFs are at least three times as likely to develop Alzheimer's disease as those without significant exposure. Dr. Eugene Sobel was scheduled to report at the Fourth International Conference on Alzheimer's Disease and Related Disorders in Minneapolis. In comparison, the cancer risk associated with EMFs is generally believed to be 1.5 to 1.8 times as high among those with occupational exposure.

Dr. Sobel and his colleagues also found that dressmakers and tailors were overrepresented among Alzheimer's victims. Further study showed that industrial and home sewing machines produce much larger EMFs than other appliances.

The Forum

WEDNESDAY, APRIL 27, 1994

Section C

Stray Voltage Issue Sparking Interest

By John Sundvor
The Forum

ST. PAUL — A week after the House passed a similar bill, the Senate Tuesday voted to fund a study of so called stray voltage in Minnesota.

Stray voltage is the bane of dairy farmers throughout the state. For years, they have complained that electricity has been escaping from transmission lines and ending up in their dairy barns.

They blame the problem on the way power companies ground their transmission lines.

Before the Senate Agriculture Committee, farmers complained that solutions were not being offered for a problem they have endured for years.

Lonny Nelson, operator of an Otter Tail County dairy farm near Clitherall, told the committee that he lost 21 cows over a 13-month period because of stray voltage or ground currents. He said he could not withstand losing another 21 cows.

"Farmers have got the answer," he told the committee. "We have got the research, but the utilities won't listen to us."

Nelson said utilities must be prohibited

from using the earth as a ground for their power lines. He says once the electrical current enters the ground utilities lose control of it.

Otter Tail Power, he said, must use some of the \$27.3 million the cooperative realized in profits last year to fix its transmission lines. Devices are available, he said, that can stop the escape of electricity.

Nelson said Otter Tail Power is relying on a "system that was built in 1936." Instead of milking the system, he said, the company should start updating it.

The Senate bill orders electric utilities in

Minnesota to provide \$603,000 for the study. Sen. Dallas Sams, DFL-Staples, said the money will be used to fund a survey of existing research and to do some original research on stray voltage and ground current.

"I don't think this is an issue that is going to die," Sams said. But he says the state must find out how widespread the problem is before it can be solved.

The utilities are willing to participate in the assessment, he said, "because they want to get this behind them." The study must be completed by June 30, 1996. Sams said it "should tell us if there is or isn't a problem."

Debate Rages on Electrical-Field Effects

Professors Warn Of Harm to Health

Two college professors drove to town recently and sat down with leaders of Omaha Parents for the Prevention of Cancer to talk about the effects of electricity on people and farm animals.

The parents' group had asked Professors Duane Dahlberg and Larry Falk to describe their research and other scientists' findings on the health effects of stray voltage and electromagnetic fields.

Dahlberg is a professor of physics at Concordia College in Moorhead, Minn., former chairman of the Minnesota Pollution Control Agency and a researcher on EMFs and stray voltage.

Falk is a professor of sociology who recently retired from the Moorhead faculty. A Nebraska native, he recently moved to Nebraska City, where he continues to do research with Dahlberg.

The professors have concluded that EMF emissions and stray voltage — which emanate from electrical sources and wind up in the ground and elsewhere — are a hazard to farm animals and people.

But power company officials say the professors are incorrect. And the dean of Mississippi State University's veterinary medicine school says research has not shown a link between illness, stray voltage and EMFs.

The conflicting views point up the public's difficulty in determining how to respond to the growing amount of electricity in their daily lives — from power lines, transformers, substations and myriad devices at home and work.

Such sources include computer terminals, sewing machines, clocks, blankets,

Your Environment

By Fred Thomas



microwave ovens, televisions and water bed heaters.

Done Research

Dahlberg has done research on stray voltage, EMFs, dairy cattle and people for 11 years.

Because of research by Dahlberg and others, the last Minnesota Legislature passed a law requiring the state's public utility commission to appoint a team of scientists to study how power companies use the earth to carry currents and the possible effects of this technology on farm animals and humans.

Last weekend, University of Southern California researcher Eugene Sobel reported that studies show EMFs are linked to Alzheimer's disease. He said dressmakers, tailors and others who have a high occupational exposure to EMFs are far more likely to develop Alzheimer's than people without significant exposure.

In Omaha, Dahlberg recommended these steps to reduce risks:

- That power companies control stray voltage and EMFs so fewer people and animals are threatened.

- That utility companies place high-voltage lines, transformers and substations as far away from people's homes, sports fields and workplaces as possible. He opposes locating recreational trails

and baseball and soccer fields under high-voltage lines or near power towers.

- That "people look at themselves and their habits," to reduce exposure.

He cited how much people play video games, how close they sit to the TV, how close they stand to microwave ovens, whether they use electric blankets and their physical relationship with "any device that uses electricity."

Dahlberg's last point coincides with the view of several authorities who recommend that people use "prudent avoidance" while studies are done on the effects of EMFs on health. Several agencies have published guides which recommend how far away people should stay from electric appliances.

Developed Cancer

The Omahans told Dahlberg and Falk that a number of Omaha children whose homes are near high-voltage lines, transformers and substations have developed cancer.

The professors recommended two steps:

- Circulate their "questionnaire about human well-being" in those neighborhoods.

- Have scientists do studies of health problems along electric transmission corridors and around substations.

Dahlberg said he doubts that utility officials will ever admit an EMF link with illness. There's a question of legal liability, and any admission would force power companies to make costly changes in their transmission systems.

Meanwhile, the utilities are awaiting results of a multimillion-dollar EMF study the U.S. Environmental Protection Agency is conducting. Results are four years or more away.

Ron Bogus, Nebraska Public Power District spokesman in Columbus, said

many authorities refute claims by people such as Dahlberg.

On the issue of dairy cattle, Bogus suggested calling Dr. Dwight Mercer, dean of veterinary medicine at Mississippi State University and a veterinarian with a doctorate in pharmacology and toxicology.

Mercer, interviewed from Mississippi State, said many studies have been done and "the data do not support the contention that EMFs have an effect on cattle."

He said claims that stray voltage and EMF fields have harmed dairy cows and altered milk production "have not been verified in reputable studies."

He said several studies were done on cows and pigs that were deliberately kept under high-voltage lines for long periods of time. The animals failed to become ill or show any change in their reproduction, he said.

No Ill Effects

Thousands more cattle are grazing under high-voltage lines each year and they don't show ill effects, he said.

Mercer said most stray voltage comes from faulty wiring and malfunctioning equipment. A farmer would correct those problems because they are safety hazards, he said.

He said a lot of data is available to show no link has been established between EMFs and animal health, but some people "fail to read and understand and comprehend that kind of study."

"I go with what controlled data show us," he said. "That data have allowed me to form an opinion: I think they are chasing phantoms."

Mercer said he has not done research into EMF effects on people.

Stray voltage action advocated

By Joanie Matchey

I can't believe Mark Glaess, manager of the Minnesota Rural Electric Cooperatives Association, is so blind to the problems that exist here in rural America from extraneous (stray) voltage and ground electric currents.

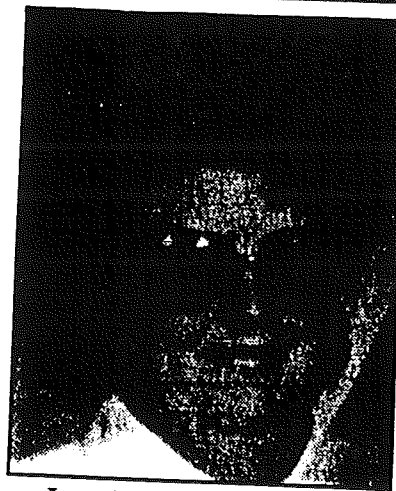
In his response to Duane Dahlberg's comments in a previous Country Today article, Mr. Glaess states "the lines allegedly inject electricity in the earth which zips here and there. At the most opportune time the electricity enters dairy farms causing havoc with the dairy cows." For that statement to come from a person managing a rural electric cooperatives' entire state association is incredible!

Have you not heard of Ohm's Law? Do you know the definition of voltage or electric current? Voltage is an electromotive force. It is measured in units called volts, and the current, it produces is measured in units called amperes. Have you any knowledge of electric resistance? Doesn't electricity take the path of least resistance?

The American utility system depends on the grounding network of its transmission lines to return electricity to its source point. If that grounding system has failed, is inadequate, or if the transmission lines carrying that return electric current have failed or are inadequate, where do you think that electric current goes — to heaven?

What if the farm electrical system has a better grounding network than the utility? Does it not dawn on you that any electrical current not able to return as designed within the utility system will find a ground willing to accept it — that well-grounded dairy farm!

Is it not true, that wherever you have current flow you have a magnetic field present? How can you state, "He makes false statements, dismisses laws governing the behavior of electricity and throws in issues like mag-



Joanie Matchey and her husband, Joe, have farmed for 15 years near Independence in Trempealeau County.

netic fields, which have nothing to do with stray voltage." Have you not heard of Hans Oerstad, George Ohm or Michael Faraday?

Can you tell me how many farms in Wisconsin and Minnesota presently have neutral isolators preventing utility-caused stray voltage? I know you can't give me the figures for Wisconsin because it's not required to be monitored by rural electric cooperatives. The Public Service Commission has no jurisdiction over Wisconsin rural electric cooperatives, nor does the REC Association, so they don't know either.

There is no state office where utilities, electricians, farmers and scientists can pool and compile information, occurrences, consequences, complaints or locations of extraneous voltage. How then, Mr. Glaess, can you make such broad assumptions and speculations regarding the scope and health ramifications of extraneous voltage on animals and humans?

You have the gall to degrade Mr. Dahlberg's theories because they're unsupported scientifically, yet your own arguments against him are not supportable. Unlike Mr. Dahlberg, you have the power, resources and connections to begin a positive

approach to this problem.

I wonder if Jonas Salk could have ever discovered the polio vaccine if those little viruses would have had shareholders, a board of directors, highly paid managers, and other self-interested individuals and groups fighting against him.

Who should do the research? There are pure scientists and sincerely motivated people out there. Some may even be electric utility people. I would like to see a collection of independent federal or state government sponsored scientists, engineers and data collectors begin a continuous program of research. It would, I hope, also be a center where individuals, such as farmers, electricians or whoever, could report problems or encounters with extraneous voltage.

An accounting needs to be made showing the extent of problems statewide. How many neutral isolators are present on farms? Where are they located? What farmer has lost his/her business because of stray voltage? What steps are utilities taking to investigate, eliminate and prevent problems?

Mr. Glaess, instead of convincing yourself and others that extraneous voltage is not a health threat to animals or humans and completely discounting people like Mr. Dahlberg, why don't you open your mind and heart to the fact that we are still suffering greatly here in rural Wisconsin from this phenomenon. This I know from the past and present destruction done to our dairy animals and reports from other people I've had personal contact with. Though I have no proof, like Mr. Dahlberg, because of the complex electrical components of our human bodies, doesn't it seem reasonable that extraneous electric current, etc., may be causing adverse health effects! Even the possibility of this happening should warrant positive action instead of the rhetoric present in your letter Mr. Glaess.

9/22/94

Country Today

10/22/94

Appendix

Blue River farmer loses stray voltage lawsuit

A Grant County jury rejected Blue River area dairy farmer Darrel Aden's suit against two power companies seeking compensation for damages alleged to be caused from stray voltage.

The jurors needed only four hours last Wednesday to make their decision that neither Wisconsin Power and Light nor Grant-Lafayette Electric Co-op were negligent in providing electricity to the farm, ending the 12-day trial.

Aden had sued the utilities for \$606,000 in compensatory damages, contending their negligence in providing power and in grounding the system resulted in a loss of production, animals, and diminution of value of what remained of the herd when sold in March of 1990 and of the potential sale value of the farm.

The utilities, however, convinced the jury that Aden's problems resulted from mismanagement of his farm.

The allegation concerning the damage to the herd from how the farm's electrical system was grounded was, according to Aden, the first suit of its kind in the country. Aden's expert witnesses testified extensively concerning the readings they had taken of the stray current on the

farm and the harm suffered by the stock.

The expert witnesses for the utilities testified that the grounding system was similar to that used nationwide, and had nothing to do with stray voltage or the problems Aden experienced. In response to Aden's attorney's questions about why they hadn't taken any similar readings, they replied that since such readings are "irrelevant," it would be a waste of time and resources.

A comment from Wisconsin Power and Light's attorney in the opening statements concerning the potential cost to the consumer if Aden's contentions were upheld was objected to and a mistrial ruling requested. According to Aden, this might serve as grounds for an appeal.

Expert: Stray voltage caused by power lines

By GARY GUNDERSON
Agri News Staff Writer

MOORHEAD, Minn. — The cause of most stray voltage problems on farms may be the two-line electrical transmission lines used on almost all electrical systems throughout the United States, says a physics professor at Concordia College in Moorhead, Minn.

Duane Dahlberg, who has been studying problems with electromagnetic energy on farms for seven years, said that with the two-line system, one line is used to transmit power, while the other line completes the circuit by returning the electricity to its source and serves to ground the system.

The problem lies in using the return line

as a ground, Dahlberg said in a telephone interview. The earth is a good electrical conductor, and about 60 percent of the return line's current goes through the ground wire into the soil.

Once in the soil, electricity can be picked up by animals and humans through their feet, especially on concrete floors, Dahlberg said, and by touching items that conduct electricity through the ground.

Electromagnetic energy may also escape into the atmosphere by radiating from power lines, he said.

A solution to the suspected problems with electricity in the ground would be a three-wire system in which the third wire would not carry current and only act as a ground wire, Dahlberg said. "That's the way they should have done it in the first

place."

But this would be an expensive solution because the present electricity transmission system would have to be completely rebuilt across the country, Dahlberg said, possibly costing several millions of dollars.

More study on electromagnetic energy is needed because of what Dahlberg said are inadequacies in past research.

Past studies have not addressed problems with animals that are exposed to continuous low-level electrical shocks, Dahlberg said. Most studies have assumed that infrequent high levels of shock are more damaging, but this type of shock is not common on farms, he said. In addition, low levels of continuous shock may be

more dangerous than strong, infrequent shocks, he said.

Kenning said levels down to .10 volts have caused lower production and illness in his cows.

Dahlberg asked the Legislature this year to provide \$1 million for a two-year study. But this request was denied, he said, because of the state's projected budget crunch.

Said Dahlberg, "It's frustrating, because people in the position to do something seem to be dragging their feet. It's the normal thing we've encountered. There seems to be no money, even though it's costing the dairy industry billions of dollars."

"Garbage electricity"

Letter To The Editor:

Farmers experiencing stray voltage, "garbage electricity," whatever name you wish to use/apply to the byproducts of electricity, have registered complaints around the state of Wisconsin including the Public Service Commission, the Wisconsin Department of Agriculture, Trade & Consumer Protection, Governor Tommy Thompson, legislators, even the Department of Justice, plus farmer vs. utility lawsuits.

Garbage electricity can/has ruined lives and livelihoods by severely affecting our livestock and, unfortunately too often, our family structures. It leaves you with nothing!

The stray voltage family is worse off than the working poor in this country.

The utilities will not guarantee us that they will prevent stray voltage from entering our farmsteads. There are lenders who require farmers to guarantee they won't have stray voltage. This is impossible!

The utilities do nothing to monitor it. The farmer is left to find it.

The utilities in the state of Wisconsin control the success or failure of every farmer by the type of electricity they deliver to his farm.

In Wisconsin a third of the present 34,000 dairy farmers are expected to go out of farming. Interestingly enough, it is being estimated that at least a third of the 34,000 dairy farmers in our state are experiencing stray voltage.

The governor, legislators and state agencies really do not seem to care.

Wisconsin Electric Power Company has stated in its recently filed tariffs to the Public Service Commission of Wisconsin that they will need six to eight years to re-do their distribution systems. It stands to reason then that farmers need a moratorium so stray voltage farmers stop losing their farms; stop-gaps must be put in place during that period by the utility preventing them from further devastation that can cause farmers to wind up on the welfare rolls or worse.

Our nation must be made to realize that still another segment - the stray voltage farmers and their families - can enter the homeless persons and families

we already have too much of. This is shameful for our nation! At present we are destroying the victims of stray voltage.

I am a combat veteran from the Korean War. Is this what I put my life on the line for?

To paraphrase Martin Luther King, "I had a dream." My dream was to own a farm and be the best. Stray voltage has taken my management abilities away from me. There isn't a farmer in this state that should lose his farm for something he has no control of. This isn't the American way.

Just recently, former-President Ronald Reagan told the Russian people how important it was to be able to own land, etc.

What is happening to the stray voltage farmers in this state is not acceptable by any standards in our democracy.

President Bush has and is sending many young men and women from Wisconsin to Saudi Arabia because Iraq took over another country. In my opinion, what is happening here in Wisconsin to dairy farmers by the utilities in this state is a similar situation and it must be stopped immediately!

As the farmer representative on the Stray Voltage Task Force and Stray Voltage Analysis Team Advisory Council, I know from the phone calls I receive from farmers all over this state - except Madison Gas & Electric's area - that every other major utility, many rural cooperatives, etc. have serious problems thus resulting in farmers failing because of garbage electricity.

This state has a disaster on its hands and it's time the blindfolds came off! Stray voltage farmers are the victims - where are our rights?

Wallace R. Daggett
Dairy Farmer Representative
Stray Voltage Task Force &
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Farm Credit Advisor
W6353 Abbott Drive
Random Lake, WI 53075

Stray Voltage: Watch the Explosion

A report from two dairy farmers to other dairy farmers: what we found out about stray voltage.

Cows don't milk? Don't breed back, showing hardly any signs of heat? No milk check coming in? Had all the experts on feeding come out to your farm? No results? Cows still the same? Why?

Have any of these things happened to you?

The vet tells you to replace them. You buy a cow with a record of over 18,000 lbs. of milk. Put her in your barn and you can't get 10,000 out of her.

You find out that the guy who lived on your farm before you went broke because he couldn't get his cows to milk.

Has your electric co-op come out to your farm with a stray voltage recorder and not hooked it up correctly, even though there are numerous publications on how to do it?

On one of our farms...

They sent out an electrical engineer who took readings at 12:15 p.m., when power usage is very low. A week later, a Professor Appleman at the University of Minnesota told us we got a snow job.

An electric co-op person told us to ground the pipeline to the company's neutral. Within three days after that was done, the cell count went over three million. An engineer came three days later and said the pipeline should never be grounded to the neutral.

The same person from the co-op said that 22 volts measured on the ceiling of the barn won't hurt, but a few days later when we put a milker on a cow, that same 22 volts went into the cow's teat ends.

All the grounds on the farm were cut, and everything on the farm was in balance. Then the electric company comes out to say that you can't do that. They reconnect the ground.

That same night, we read in the company's code book (pg. 65&66):

"Current in Grounding Conductor: Ground connection points shall be arranged that under normal circumstances there will be no objectionable flow of current over the grounding conductor. If an objectionable flow of current occurs over a grounding conductor **due to the use of multiple grounds**, one or more of the following should be used: 1) abandon one or more grounds. 2) change location of grounds. 3) Interrupt the continuity of the conductor between ground connections..."

The same day we took two co-op members to another farm, showed them trees in the high voltage lines. But they said it doesn't hurt anything. They must not be reading their code book about trees in high voltage lines.

We showed them a pole with three grounds, where the cows stand around. The cows are in poor shape and the vets and farmers don't know why.

We showed them old transformers on poles, with the high voltage hooked to the primary neutral, making a nice coil on the neutral. They said that they were grounding them.

We found out that on the wye, or single-phase lines, grounding works only if there is an open line to the substation. Any blockage on the primary neutral will cause all the transformers to be out of balance, and high current flow will be in the primary neutral coming into our farms.

The current on the neutral is all free AC negative electrons. This has one purpose: to make everything on your farm negative—you, your cows, metal sheds, machinery. Then when the current in the neutral line ceases, everything on your farm has to balance itself again.

If you have high voltage on the ceiling of your barn, you have a high amperage on the neutral in your barn coming from the primary neutral.

We are concerned that the power companies are hiring people who don't know enough about how electricity works and the negative effects of ionization.

There will be a stray voltage meeting Oct. 22, at 1:30 p.m. and 7:30 p.m. at the Richland County Courthouse. We ask that every farmer go to this meeting and ask some questions on the amperes and the free negative electrons on the primary neutral.

Ask why the trees and branches in the high voltage lines are not cut. Why do they leave the old transformer's high line hooked to the primary neutral? If they have a code to stop the flow of free negative electrons or current on the neutral, why don't they do it??

Again, we urge every farmer to get to this stray voltage meeting, and we thank you for reading this.

To talk about stray voltage, call Frank D. Braun, P.O. Box 171, Richland Center, WI 53581, (608) 647-4270 or Darrel Aden, at (608) 537-2053.

Anyone wanting to learn more about stray voltage is invited to a meeting in the Eichen machine shop in Blue River at 8 p.m., Monday, Oct. 19.

No longer a topic unique to university research facilities and scientific journals, the properties of electricity are getting a thorough airing in courts of law these days. Experts drawn from various academic disciplines and the electric trades are turning up on the witness stand—some to challenge conventional wisdom about how electricity behaves in certain circumstances, others to reaffirm long-held, proven ideas concerning electric power.

Typically, the settings for these confrontations are court cases where plaintiffs assert some form of electrical mishap has harmed them or their property. Defending themselves in many of these lawsuits are electric power suppliers, those who operate the systems that deliver electricity to homes, farms, and commercial property.

Such was the situation in a Grant County court recently, where a dairy farmer claimed the systems of two electric utilities caused health and production problems for his cows.

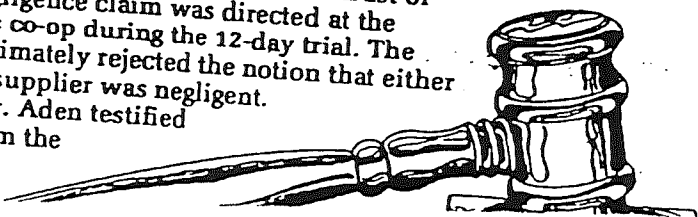
To the casual observer, the suit brought by Darrel Aden against Grant-Lafayette Electric Cooperative and Wisconsin Power and Light Company might have appeared similar to numerous cases in recent years where the phenomenon commonly referred to as "stray voltage" was being accused of harming cattle.

As utilities and farmers have come to know it, stray voltage is typically a small amount of electricity leaving its normal course along neutral wires as it seeks a path to the ground. If cattle come in contact with a source of neutral voltage, barn conditions may allow their bodies to be part of the electrical pathway, and these low voltages can be felt by the animals. Left unchecked over time, stray voltage can cause a variety of health problems.

That's the usual scenario described in court cases involving stray voltage. However, the Aden case broached some electrical propositions that haven't been appearing on the legal dockets in Wisconsin, according to Denis Vogel, the attorney representing Grant-Lafayette Electric Co-op in the case.

Aden, who operated a 60-cow dairy farm in northern Grant County, claimed ground currents and voltage surges (in addition to stray voltage) were behind health and production problems his herd experienced, and he sued the utilities that provided electric service to his two adjacent farms. The farm maintaining the milking operation was served by Grant-Lafayette REC, so the main thrust of the negligence claim was directed at the electric co-op during the 12-day trial. The court ultimately rejected the notion that either utility supplier was negligent.

Mr. Aden testified from the



Electric utilities take life witness stand

Vogel said it appeared that Aden would have had a hard time building a case using the stray voltage measurements alone. However, the case included allegations that stray voltage was acting in concert with other electrical experiences that were unaccustomed to courtroom scrutiny. Hence, the court case—thought to be the longest in Grant County history—delved into the principles of physical science.

Electrical "expert witnesses" brought by Aden to help argue his case professed some theories that defense witnesses needed to challenge, Vogel said. One such assertion that warranted a thorough rebuttal, according to Vogel, was that ground currents were responsible for stray voltage-like symptoms in Aden's livestock.

A basic understanding of electricity acknowledges that to have a complete circuit, there has to be a path for electricity to return to its source. This is the purpose of a neutral wire on electric distribution systems. In order to keep return voltages low and to protect systems and their users against faults and lightning, electrical systems are grounded—usually by having neutral wires connected to rods driven into the earth. Current can therefore also flow down the neutral wire and use the earth as a pathway to complete the circuit. As a general rule, electricity will take the path of least resistance.

Vogel said Aden's "experts" essentially maintained that ground currents were coming out of the earth, flowing through cows, and then returning to ground—a highly unusual pathway because of the differences in electrical resistance that would be involved. "The cooperative experts told me that, scientifically, it doesn't work like that; it just ain't so," said Vogel, who contradicted testimony given by several prominent researchers called on behalf of Grant-Lafayette Electric Co-op.

These witnesses also dismissed assertions made by another of Aden's witnesses, an engineer who promoted use of electrical systems with either limited or no grounding.

"Our electrical experts maintain that this would be unsafe," Vogel asserted. "They say the co-ops wouldn't dare have a uni-grounded or ungrounded system on a farmstead. You'd have more than animals injured or killed before too long," he said, citing electrocutions that occurred last year on one of the few ungrounded electrical systems operating in the U.S.

Defense witnesses also critiqued measuring methods and data used by Aden's experts to allege that voltage

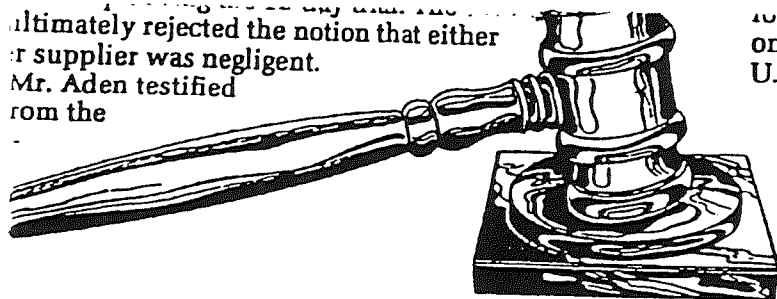


Grant-Lafayette stray voltage case decided

(continued from page 2)
above and beyond what was normal, something they couldn't handle," said Vogel. "The answer in this case was no."

He noted the 12 men and women jurists were without dissent in finding Grant-Lafayette Electric Co-op and the other utility not negligent. Beyond that, they found the farmer himself negligent for

ultimately rejected the notion that either
supplier was negligent.
Mr. Aden testified
from the



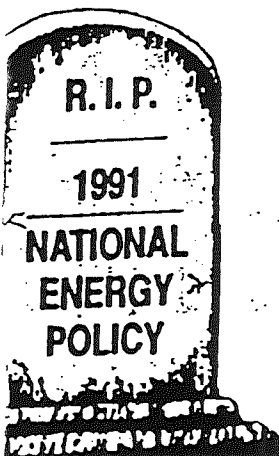
of his farming operation (1976) he had problems—later
ed to at the trial as *electrical pollution*,” Vogel said,
ning that the “pollution” was said to include traditional
voltage, ground currents, and impulses, or voltage
“The plaintiff claimed these acted together to cause
ical symptoms attributed to stray voltage, including
f water intake, cows dancing in their stalls, tails switch-
or milk letdown, mastitis, and cow deaths.”
chard Kolb, manager of Grant-Lafayette Electric Co-op,
andard stray voltage measurements taken at the Aden
n many separate occasions by the co-op revealed no
for concern. “Stray voltage is an undeniable condition
n exist in some dairy operations,” said Kolb. “However,
Aden’s situation, the readings did not indicate this was
blem.”

ional energy cy dies

The concept of a national
energy policy is dead for now.
U.S. Senate opponents of the
bill that cleared the Energy
Committee in the spring of 1991
overcame efforts by the bill’s
supporters to shut off a filibuster,
dooming the proposal’s
prospects for action before
Congress adjourned.

Opposition to the bill centered
on two provisions: oil
development in an Alaska
wildlife refuge and quicker licensing
for nuclear plants. Similar legislation
is under consideration in several House
committees.

The bill’s backers say they



long. He said, citing electrocutions that occurred last year on
one of the few ungrounded electrical systems operating in the
U.S.

Defense witnesses also critiqued measuring methods
and data used by Aden’s experts to allege that voltage
“spikes” had affected cows. Testimony and cross-exami-
nation revealed that the machine used to take surge meas-
urements had not been hooked up properly on one
occasion, and the readings were not interpreted correctly
on any occasion, said Vogel. In addition, the general
theory of how voltage surges might affect animals was
also discussed, with defense witnesses taking a dim view of
the scenario offered in the plaintiff’s testimony.

“The engineers tell us there are voltage surges happening
all the time, but assert they are so short in duration—some in
the billionth-of-a-second range—that nothing living can
perceive what is going on,” said Vogel.

Given the various electrical circumstances described at
the trial, the jury basically needed to decide what Aden’s
dairy cows themselves had encountered. “The decision was
whether or not the animals had been experiencing something

(continued on page 11)

DO YOU KNOW SPACE HEATER SAFETY FEATURES?

Portable space heaters can help you
and your family keep warm and cozy on
those very chilly days. But, please make sure
your heater provides these safety features:

- A tip-over switch that shuts off the heater if it’s
knocked over.
- An overheat sensor that shuts off the unit if the heater
gets too hot.
- A low surface temperature to help protect you and your family from
burns.
- A screen or grill to help prevent children from sticking fingers and
toys in the heater.

For heating a bathroom, choose a heater designed especially for bathro



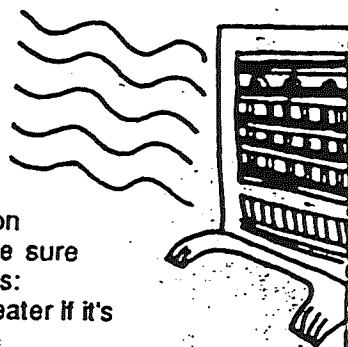
If you need more space heater information, please contact
your cooperative. We’re happy to help you keep your home warm

Lafayette Electric Co-op and
the other utility not negligent.
Beyond that, they found the
farmer himself negligent for
lack of attention to a number
of on-farm problems.

“Many symptoms that are
often attributed to stray volt-
age are also common to other
unrelated herd health prob-
lems,” said Kolb. “These pos-
sibilities should be looked at
by a veterinarian, and his or
her recommendations should
be followed.” He said the co-
op had visited Aden’s farm
many times to address
concerns and offer sugges-
tions, and would do the same
for any member who suspect-
ed he or she may have an
electrical problem.

Kolb, who manages one
of 27 electric cooperatives
across the state, said he has
routinely found REC manage-
ment and staff to be “com-
mitted to working with all of
their members, no matter
how difficult the task, no
matter what the risk.”

“The cooperatives must
be keenly sensitive to the
well-founded complaints of
farmers,” said Kolb. “At the
same time co-ops must be
able to recognize oddball
theories and unsubstantiated
associations,” he continued.
“The complexity of the
subject matter makes it easy
for people to be misled—
including farmers—but we
have discovered that there
are respected experts who are
willing to step forward and
point out the errors.”



Cows chew their cud and burp in name of science

PULLMAN, Wash. (AP) — Cows will soon be chewing their cud — and burping — for science.

Washington State University researchers exploring the effects of livestock on global warming want to find out how much methane cows and other cud-chewing animals produce when they belch.

Cattle will be fitted with equipment in backpacks to gauge their gas emissions under a \$70,000 U.S. Environmental Protection Agency grant to determine if such methane discharges can be reduced.

Most scientists agree ruminant, or cud-chewing, livestock produce about 15 percent of all methane released into the atmosphere, said researcher Hal Westberg, who is joined in the project by colleagues Brian Lamb and Kris Johnson.

Scientists say methane is contributing to the greenhouse effect — the accumulation of chemicals in the atmosphere believed to be causing changes in the world's climate.

The leading sources of methane are natural

wetlands, estimated to account for 20 percent of the gas.

Lamb said he isn't sure if the cow-produced methane is of global importance, but any reductions would help.

Each cow backpack contains a gas monitor connected to a tube placed near the cow's mouth. The first step will be to measure just how much methane the animals belch while they're digesting, Westberg said.

The researchers hope to outfit hundreds of animals by the three-year project's end, he said.

Stray voltage destroys farmer's dairy herd

PLAINWELL, Mich. (AP) — In 1978, Paul VanDenBerg began noticing a drop in milk production at his successful dairy farm.

Soon after, many of his cows became sick and eventually died as VanDenBerg watched in frustration.

Only recently was he able to prove the cause: An electrical phenomenon called stray voltage that scientists believe may be zapping the livelihoods of many farmers.

In September, VanDenBerg and his wife, Judy, received a \$750,000 settlement from Consumers Power Co., which they sued in 1985, alleging that stray voltage was giving their cows shocks of varying intensity and causing stress, poor milk production and disease.

But more important to the couple than money, they say, is the affirmation it was stray voltage and not poor management that led to the decrease in milk production and the loss of 500 cows at their Allegan County farm.

"The farm game's been rough this year," VanDenBerg said. "We can't revive the farm game, but we can't revive electrocution."

Stray voltage, a generic term for neutral-to-earth voltage, is a common phenomenon in most of the nation's utility systems that use the earth as a conductor to return electrical power to its source.

Only recently has there been any scientific data to back up farmers' assertions that stray voltage can severely affect livestock.

The VanDenBergs said they believe their dairy barn became part of the power-return loop to Consumers' substation because of a poorly placed and inadequately grounded transformer pole on their farm. When the cows came into the barn to eat, drink and be milked, they were jolted with shocks of varying intensity.

The jolts caused them to avoid eating and drinking properly, resulting in an immediate milk production drop and eventual sickness.

The stray-voltage issue has been baffling for farmers and utilities, said Alan M. Lefcourt, a biomedical engineer at the U.S. Department of Agriculture's milk secretion laboratory.

"The utilities couldn't go anywhere and identify that this was

a problem," Lefcourt said. "To have farmers saying their cows were affected by stray voltage was like saying flying saucers were affecting their cows."

When the VanDenBergs first noticed milk production problems in 1978, they replaced their milking system three times and hired several experts and electricians to help them pinpoint the source of their problem.

They suspected an electrical problem off the farm, but frequent inspections by Consumers always ended with the same finding: The problem is on the farm, probably poor management.

An ice storm in 1984 turned things around. Power was knocked out in the area and the family was forced to use a generator for seven days.

"Our milk production went up a

thousand pounds that week, and that's when we knew it wasn't us," VanDenBerg said.

Last month, as part of the settlement, Consumers told the VanDenBergs it would isolate their farm, putting them on their own power line.

The utility checks about 100 inquiries a year, and about half those complaints result in some corrective action, said Ronald L. Spees, a senior engineer at Consumers.

Last month, a Jackson County pork producer filed suit against the utility for \$500,000, alleging that stray voltage killed up to 1,000 of his hogs. Jon S. Fox alleges that electricity leaked into the ground, caused dehydration and stress among the hogs and caused them to avoid drinking. That case is pending.

The Milwaukee Journal Farmers face invisible villain as stray voltage harms cows

By ELIZABETH CULOTTA
of The Journal staff

When Wally Daggett's dairy cows take a drink, they may receive small electric shocks.

Excess electricity called stray voltage finds its way into metal drinking cups and milking equipment at Daggett's dairy farm near Random Lake. The stray voltage has caused his 200 dairy cows to become nervous, drink too little water and even develop bleeding ulcers and udder infections.

Daggett received more than \$1 million from Wisconsin Electric Power Co. in a 1984 judgment after filing suit in Sheboygan County. Since then, a handful of other dairy farmers have sued the utility over stray voltage and won, or settled out-of-court for substantial sums.

And for the first time, the state budget passed by the Legislature Thursday includes \$188,800 to educate farmers about stray voltage, said a spokesman for the amendment's sponsor, Rep. Barbara Gromelius (D-Buffalo).

The problem is that utility wiring systems were designed for humans, and cows can feel lower levels of electricity than humans can, said Ron Legro, public information officer for Wisconsin Electric. "It's a real problem for us," he said, "frustrating, subtle and hard to detect."

Stray voltage on a farm can mean decreased milk production, loss of stock and economic hardship for farmers. Hundreds or even thousands of Wisconsin dairy farmers may have the mysterious problem, according to officials of the State Department of Agriculture, Trade and Consumer Protection.

At this point, no one knows how much production is lost because of stray voltage, how many farms are affected, or how much it might cost to keep electricity away from cows.

Up to 25% of milk production may be lost on an afflicted farm, according to Bob Ehert, executive assistant at the agriculture department.

To protect prize-winning cows brought to the State Fair in August, concerned state officials have ordered inspections of electric wiring to detect any stray voltage at State Fair Park in West Allis.

Stray voltage is found "everywhere there is electricity," said James Prothero, an engineer with Wisconsin Electric. The excess voltage is the normal consequence of moving electricity through power lines, he said.

Ironically, the electricity gets to the cows because of a safety feature,

explained Robert Appleman of the department of agricultural engineering at the University of Minnesota. Small amounts of electricity normally bleed off high-voltage lines or electrical equipment into grounding wires designed to carry excess electricity. For safety in case of lightning or short circuits, the grounding wires are hooked into the cow's motorized milking equipment and metal drinking cups.

Stray voltage becomes a problem when extra current surges along grounding wires, seeking the path of least resistance — often a cow. A variety of poor wiring conditions on a farm or in utility power lines may send electricity coursing into a barn, utility officials say.

However, farms plagued by stray voltage often are served by power lines identical to those of farms without stray voltage problems, according to Wisconsin Electric's Legro. Engineers also do not understand why certain areas, like Random Lake, are hotbeds of stray voltage. "From the utility's point of view, there's no difference there," Legro said.

When cows receive small shocks from their drinking cups or milking equipment, they may drink less and they may give less milk. After steady exposure to stray voltage for six months, chronic udder infections may mean that a "cow will never make money again (and) you might as well sell her," Daggett said.

Exactly how much stray voltage is too much for a cow is unknown; anything from one-half to two volts or more may be considered dangerous, according to farmers and state officials. Humans can feel electricity at about four volts.

Pigs are even more susceptible to voltage than cows are, Legro said, but pigs generally do not touch metal objects in the barn. So most complaints have come from dairy farmers, he said.

To tackle the problem, the agriculture department last year created a Stray Voltage Task Force composed of farmers, including Daggett; utility officials; and representatives of the agriculture department and the state's Public Service Commission.

The combined task force created a Stray Voltage Attack Team to research the problem. Ten Wisconsin dairy farms were chosen as research sites to explore sources, solutions and preventive measures. More than 100 farmers volunteered to work with the team.

Their research report, due in early August, will offer strategies to combat stray voltage and suggest who should pay the costs, according to PSC member George Edgar.

Remedies for stray voltage vary widely in cost and sophistication. To install a sheet of metal across the entire barn floor to prevent electricity from traveling through cows costs about \$5,000, a small sum compared with the cost of milk production and stock losses, Daggett said. But to replace two miles of power line, Wisconsin Electric must spend more than \$50,000. Wisconsin Electric representatives declined to reveal how much it will cost the utility to replace the entire distribution line to Daggett's farm.

Although stray voltage can be reduced, it cannot be eliminated, utility officials emphasize. When fighting stray voltage, "You can't do it once and wash your hands of it. You have to keep monitoring," agreed Ehert of the agriculture department.

Daggett thinks that 95% of stray voltage problems can be overcome. But he says that even after installing \$7,500 worth of new electrical equipment, he lost 23 cows to stray voltage last spring. Wisconsin Electric crews work at his farm "just about every week now," trying to rid his barn of stray voltage.

Half of Franklin officials file financial statements

Franklin — About half of the city officials and employees required to file financial disclosure statements under Franklin's new ethics code did so by the original deadline of July 1.

But those who didn't meet the deadline apparently will face no penalties, city officials say.

All men will take up the issue again tonight at a Committee of the Whole meeting.

The July 1 deadline was part of

Thompson, City Engineer John M. Bennett, and Aldermen Elaine Franklin and Mary Thomas.

Miazga said, "It shows many people who serve on our boards and commissions are committed to openness and honesty in government."

The code requires officials to disclose ranges of income if they own more than 10% of a company doing more than \$1,000 worth of business with Franklin in a calendar year.

Stray electricity keeps dairy cows jumping

KENYON, Minn. (AP) — Something was spooking Keith and LeAnn Cook's cows. Some nights, the animals were so upset they couldn't be milked.

"They were wild," Cook said.

It took two years and a jolt to a creamery worker to determine that electricity was leaking from power lines through the steel walls and metal pipes in the barn, giving the herd two- or three-volt charges every time Cook brought them in for milking.

Cows have lower internal resistance to electrical currents than humans, making them more sensitive to stray voltage, which shocks them through the ground. Researchers have recognized stray voltage as a problem since the 1940s. Lately, more and more dairy farmers are reporting problems with it. One report estimates 11 percent of the Minnesota dairy farms are affected and a similar Wisconsin study found 30 percent of the dairy farms there affected.

Courts and governments are starting to help.

The Cooks won a \$405,000 judgment against the Goodhue County Cooperative Electrical Association in June, the second major stray voltage verdict in favor of farmers in Minnesota this year.

The Cooks claimed the co-op knew about stray voltage problems since 1979 but failed to warn farmers or inspect and maintain its power lines. The co-op's insurance company, which is planning an appeal of the award, has said the Cooks' problems weren't the co-op's fault.

Minnesota's Public Utilities Commission is trying to define the obligations of utilities in stray voltage cases. The Minnesota Environmental Quality Board has a committee making recommendations to the Legislature and state agencies.

The U.S. Agriculture Department recently lowered its allowable standard for stray voltage to two volts. The rules were vague before, but they allowed more than three volts. In Wisconsin, the nation's leading dairy state, the maximum is one-half of a volt.

Some say the USDA's level is too high.

"The cows have to light up in the dark" before the federal guideline triggers any action, said Jim Kaster, a Minneapolis attorney who won a \$1 million stray voltage judgment against Northern States Power in the state's other big case this year.

LeAnn Cook said the stray voltage problem eventually drove her family out of the dairy business.

"We couldn't keep cows," Cook

said. "They died. They got sick. They got thin. I think we were on the edge of animal cruelty. It was horrible."

Utilities blame poor farming practices, improperly installed or outdated wiring, and resistance to the flow of current in grounded power lines.

"Many of the barns are year old," said Bill Czerniak, an engineer with Northern States Power. "And farmers have added to the load without the proper wiring."

Northern States Power is advising customers in advance about potential problems and sends out crews to deal with them, said its attorney, Jim Altman.

Still, the debate continues.

"You're obviously going to get different opinions from different parties," said Michael Michaud of Minnesota Public Utilities Commission. "There is no consensus, that's for sure."

Memphis, Tenn.
(AP Photo)

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JOHN RITTER PAM DAWBER

STAY TUNED

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Southern Hills 12

SPECIAL ENGAGEMENT - NO PASSES OR DISCOUNT TICKETS ACCEPTED

(12:50 • 3:00 • 5:10 • \$3.00) 7:30 • 9:40

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3 Ninjas

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Dairy farmer wins suit over electric voltage

Associated Press

WILLISTON, N.D. — A jury has awarded \$429,506 to a Ray farmer who said stray voltage from power lines near his farm caused his dairy cows to produce less milk.

Williston attorney Richard McKennett said this is the first case he's aware of in North Dakota on the issue of stray voltage. Similar cases have gone to court in Wisconsin, Minnesota and Michigan.

"From that standpoint, it was kind of a landmark case for North Dakota," said McKennett, who represented Paul Larson.

"Stray voltage is electrical current that is migrating from the utility into the ground and into the cattle," he said.

A six-person Northwest District Court jury ruled against the Mountrail-Williams Electric Cooperative of Williston on Tuesday night.

Larson said his herd's milk production dropped after he installed a new piece of electrical equipment in his milking parlor in 1980.

The co-op determined in July 1985 that stray voltage was not excessive at the Larson farm, but a month later the company installed a blocking device after learning that Larson had received an electrical shock while milking the cows.

McKennett said Larson's cows produced less milk because of the stray voltage, some died and some could not breed. Larson said he had to dispose of about 100 head of cattle.

"Then a number of calves that were born were either deformed or died shortly thereafter," he said.

The jury awarded damages for loss of production and cattle, increased costs and emotional dur-

Study suggests link between cancer, power lines

WASHINGTON (AP) — A leading U.S. scientist says there is statistical evidence of a possible link between cancer and exposure to electromagnetic fields that radiate from the cables and wires that electrify the nation.

The unpublished findings by Dr. Genevieve Matanoski, an epidemiology professor at Johns Hopkins University, run against the grain of traditional scientific theory about the possibility of health dangers from power distribution lines.

Her conclusions fit an emerging pattern of evidence, however, that the possibility of health risks can no longer be ruled out and should be studied more closely.

"This is consistent with my judgment ... that we'll end up seeing electric and magnetic fields are cancer promoters of some kind," said Indira Nair, a physicist at Carnegie Mellon University and co-author of a recent comprehensive background paper on the issue for the federal Office of Technology Assessment.

Ms. Matanoski said in a telephone interview Wednesday that her findings were preliminary and required further testing, but that the results changed her view of the still unproven theory about a cancer link to power lines.

"I thought before that the theory was wrong," she said. "I'm not so sure any more. I'm swayed to think it's more likely than before."

A major conclusion from her study of 50,000 New York state telephone workers are that there may be an increased risk of leukemia among active workers. Incidence rates for almost all types of cancer are highest among linemen, whose exposure to electromagnetic fields is the highest in the telephone worker group, the study found.

Ms. Matanoski also found exceptionally high rates of breast cancer among male technicians who work on central office telephone switching equipment. Her study found two cases of breast cancer among 9,500 central office technicians; ordinarily the incidence rate for males would be about one in 1 million, she said.

Ms. Matanoski said she expects to publish her findings early next year.

Any electrically charged conductor generates two kinds of visible fields, electric and magnetic. Taken together, they are called electromagnetic fields. Some scientific findings have suggested these fields can interfere with the functioning of DNA and RNA, the controllers of cell reproduction, and that they may stimulate activity in biochemistry linked to the growth of cancer.

In the century since the United States began using electric power, scientists generally have dismissed suggestions of any danger to human health.

Ms. Matanoski stressed in the interview that she was not yet convinced of any health danger, but said she no longer was willing to rule it out. She said further research with a larger number of workers was needed before she could be sure.

Her study found three cases of leukemia among 4,500 linemen; an incidence rate seven times higher than among other telephone workers. The overall rate of cancers of all types among linemen was nearly twice as high as among other telephone workers.

The electric power industry already has shown signs of concern about the Matanoski findings. Earlier this month, officials of the Electric Power Research Institute, an industry group, sent letters and briefing papers to utility executives noting that Ms. Matanoski's results "may attract national attention because they suggest an increased risk of cancer."

Power industry officials disagree. Spokesmen Henry Sterba of the Omaha Public Power District and Ron Bogus of the Nebraska Public Power District said studies have not proved that EMFs and cancer are linked. Their districts are awaiting results of a multi-million-dollar, five-year study that hopes to prove or disprove a link.

The study is just beginning. Scientists say that in the meantime people should practice "prudent avoidance" — reducing exposure to EMFs.

Last week Mrs. Hendricks and Mrs. Larm started a campaign to get people to write Gov. Nelson and OPPD Director John Green to encourage them to reduce EMF emissions.

Working at their own expense, the women also speak to church and civic groups and pass out leaflets that suggest ways to reduce exposure to EMFs from televisions, microwave ovens and other appliances, hair dryers, electric blankets, waterbed heaters, alarm clocks, computer screens, power lines and transformers.

Mrs. Hendricks gives away copies of a homemade "coloring book" that describes EMFs and health risks. Power districts distribute materials on EMFs and how to be safe around electricity.

OPPD and NPPD offer free tests with a meter that shows EMF levels in homes and businesses. The power districts do not interpret the results.

OPPD also is lending

Crusade of Families To Warn of EMFs Attracts Boosters

Calls and letters are coming in increasing numbers to the homes of Dee and Craig Hendricks and Julie and Steve Larm in Omaha.

They are from people in various walks of life, including:

■ A state official who sent a medical journal report that indicates children living near high-voltage power lines run a higher risk of getting cancer than children who don't.

■ A cancer researcher who says he can't speak out publicly but encourages Mrs. Hendricks and Mrs. Larm to continue pushing for utilities to reduce electromagnetic field (EMF) emissions from power lines and transformers.

■ A cancer survivor who built a fence around the transformer in her yard to keep children from playing near it.

■ Home buyers and real-estate agents seeking advice on how close to power lines people can live and not be worried about potential EMF hazards.

Mrs. Hendricks and Mrs. Larm are co-founders of Omaha Parents for the Prevention of Cancer.

They formed the group last spring after a Nebraska Health Department study indicated a statistically high number of children have been diagnosed with cancer in an area bounded by 72nd Street, 156th Street, Blondo Street and Interstate 80.

A state health official said he did not know whether the high cancer incidence happened for a reason or whether it was a statistical aberration that would vanish if the area were studied for five years.

Children Stricken

The Hendricks and Larm families each have a child stricken with cancer. They believe that the cause was EMF emissions on their property.

Power industry officials disagree. Spokesmen Henry Sterba of the Omaha Public Power District and Ron Bogus of the Nebraska Public Power District said studies have not proved that EMFs and cancer are linked. Their districts are awaiting results of a multi-million-dollar, five-year study that hopes to prove or disprove a link.

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Meter for Loan

OPPD also is lending

Your Environment

By Fred Thomas

readings. A concerned Omaha soon will have a meter of its own to n readings.

Mrs. Hendricks and Mrs. Larm want people to take EMF readings where children congregate, such as at school, day-care centers, sports fields and community centers. Parents in other cities have done so.

After studying readings, Mrs. Larm said, she plans to give an opinion what a family might do. She subscribes a Swedish theory that long-term exposure even to low EMF levels can be harmful.

OPPD is studying a request by Omaha Parents for the Prevention of Cancer: the utility attach stickers on transformers and other equipment to warn people about EMF emissions. Mrs. Larm believes that her son was stricken because he often played in a sandbox near a transformer in the Larms' back yard and on the transformer itself.

OPPD is reducing EMF emissions new transmission lines, such as one Fort Calhoun and one proposed along Street in west Omaha and suburb Sterba said.

Mrs. Larm and Mrs. Hendricks say they hope OPPD allows their group to be a citizens advisory committee to OPPD board. Sterba said OPPD would meet with the group as requested, but said he didn't know of any formal advisory tie. OPPD has its own in-house EMF committee.

The women hope to meet with the OPPD board, Omaha City Council home builders and others.

Mrs. Hendricks wants builders to attach electrical cables and meters to garages or parts of homes some distance from bedrooms and other rooms where people spend many hours. She said she believes that her son's cancer was triggered by EMFs from electric lines and a meter entering the house near his baby bed.

200 Groups in U.S.

About 200 groups in other U.S. cities have similar concerns, Mrs. Larm said.

Mrs. Larm said she asked Paul Brodeur, a New Yorker magazine writer who has written extensively about EMFs and cancer, to visit Omaha and assess the situation. But Brodeur said that Omaha differs little from other cities and that he can't get everywhere.

His new book, "The Great Power-Line Cover-Up," has been attacked by power officials who say he used "selective reporting" in trying to prove his thesis.

Sterba said Brodeur is a journalist out to sell books, not a scientist.

Sterba said if people would call state health departments in communities Brodeur writes about, they would find little support for his opinions.

If the link between EMF and cancer had been proved, specialists at the University of Nebraska and Creighton Uni-

Expert: Stray voltage caused by power lines

By GARY GUNDERSON
Agri News Staff Writer

MOORHEAD, Minn. — The cause of most stray voltage problems on farms may be the two-line electrical transmission lines used on almost all electrical systems throughout the United States, says a physics professor at Concordia College in Moorhead, Minn.

Duane Dahlberg, who has been studying problems with electromagnetic energy on farms for seven years, said that with the two-line system, one line is used to transmit power, while the other line completes the circuit by returning the electricity to its source and serves to ground the system.

The problem lies in using the return line

as a ground, Dahlberg said in a telephone interview. The earth is a good electrical conductor, and about 60 percent of the return line's current goes through the ground wire into the soil.

Once in the soil, electricity can be picked up by animals and humans through their feet, especially on concrete floors, Dahlberg said, and by touching items that conduct electricity through the ground.

Electromagnetic energy may also escape into the atmosphere by radiating from power lines, he said.

A solution to the suspected problems with electricity in the ground would be a three-wire system in which the third wire would not carry current and only act as a ground wire, Dahlberg said. "That's the way they should have done it in the first

place."

But this would be an expensive solution because the present electricity transmission system would have to be completely rebuilt across the country, Dahlberg said, possibly costing several millions of dollars.

More study on electromagnetic energy is needed because of what Dahlberg said are inadequacies in past research.

Past studies have not addressed problems with animals that are exposed to continuous low-level electrical shocks, Dahlberg said. Most studies have assumed that infrequent high levels of shock are more damaging, but this type of shock is not common on farms, he said. In addition, low levels of continuous shock may be

more dangerous than strong, infrequent shocks, he said.

Kenning said levels down to .10 volts have caused lower production and illness in his cows.

Dahlberg asked the Legislature this year to provide \$1 million for a two-year study. But this request was denied, he said, because of the state's projected budget crunch.

Said Dahlberg, "It's frustrating, because people in the position to do something seem to be dragging their feet. It's the normal thing we've encountered. There seems to be no money, even though it's costing the dairy industry billions of dollars."

Weekly World News Magazine 11-22-

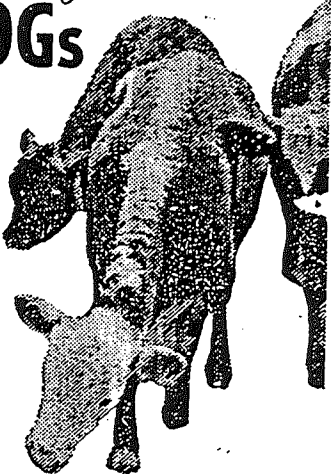
Farmers will get \$750Gs for their electric cows!

A Michigan couple will get \$750,000 because their dairy cows suffered reproductive and behavior problems caused by electricity leaking from a nearby power line.

The stray electricity caused the cows to act in strange ways, such as drinking their own urine.

The weird behavior by the electrified cows has hampered milk production on the Plainwell farm of Paul and Judy VanDenBerg since the mid 1970s.

to stop the leakage from the power line.



Downed Wire Causes Stray Voltage Crisis

Frank and Thelma Pesola have done more than their share to cut the milk surplus.

Like many other dairy farmers who have had serious stray voltage problems, their herd production dropped dramatically.

But their situation is different than most. The source of their stray voltage was an electrical wire laying on the ground on a neighboring farm.

Bob Appleman, University of Minnesota extension dairyman, and Harold Cloud, ag engineer, have dealt with several hundred stray voltage cases the past six years, and in only a few others has the voltage originated from an electrical fault on another farm.

New Herd

The Pesolas built a 46-stall barn on their New York Mills, MN, farm in 1980. They bought 24 high-quality cows, eventually building their herd to 33 cows milking.

Their problems started with a serious mastitis outbreak in the fall of 1982. During the following year, they treated many cows, some so often that their udders were permanently damaged. And even those that didn't get mastitis were nervous during milking and wouldn't milk out properly.

Cows wouldn't eat all their grain and seldom ate silage. Some were bred eight or nine times and still wouldn't settle.

Attempting to solve the problem, the Pesolas had their milking equipment checked and their feed tested. They even learned new milking techniques. They also spent many hours with their veterinarian trying to find an effective mastitis cure.

The problem was diagnosed as stray voltage last November. Using a hand-held voltmeter, their Land O'Lakes fieldman measured 3.96 volts in their barn.

Several days later, their power supplier traced it to a neighbor's farm, one-fourth mile away. A 110-volt wire leading from a shed to a pump on a fuel tank was laying on the ground. When that wire was removed, voltage in the Pesola barn dropped to 0.02.

BY LORI SCHAEFER

The behavior of their cows changed almost immediately. Before long, grain and silage consumption increased, and production began to stabilize.

But they're still experiencing problems which they believe are related to the stress the cows were under. Cows too-often freshen with milk fever or ketosis and many still have mastitis.

The financial losses have been a big burden. In fact, if the stray voltage hadn't been found when it was, they claim they would have been forced out of business. They estimate that their total losses have reached at least \$60,000. That figure includes lost production, the value of culled cows, veterinary bills, etc.

Fortunately, they have a second income. Frank has a building siding and remodeling company, but had planned to give it up and become a full-time dairy farmer. Now it looks like he'll have to retain his sideline business.

Frequent Symptoms

Bob Appleman and Harold Cloud point out that uneven milkout, usually resulting in more machine stripping and longer milking times, is the most-frequently-reported stray voltage symptom. Nervousness, reluctance to eat and drink, and lower production are other possible signs.

A high incidence of clinical mastitis also is commonly reported in affected herds. But, according to Appleman and Cloud, nobody knows for sure if stray voltage causes mastitis, ketosis, milk fever or other health problems. More research is needed, they say.

Cloud says a 110-volt wire leaking electricity into the ground could cause a stray voltage problem a mile or more away. But, as mentioned above, a nearby farm is an infrequent source of the problem.

Stray voltage originated off the farm in a substantial number of the cases Appleman and Cloud have dealt with, entering via the power company's primary neutral system. When it originates on the farm, possible causes include an imbalance of the two 120-volt circuits, worn wiring, inadequate grounds or overloading of the electrical system.

Cloud figures stray voltage prob-

Frank and Thelma Pesola struggled with herd health and other problems for a year before stray voltage was measured in their barn last November.



Photos: Lori Schaefer



lems have become more prevalent in recent years because farms have become more automated, with heavier electrical loads and more grounded equipment coming in contact with animals.

But awareness of stray voltage also has increased. Extension workers, veterinarians, feed specialists and milking equipment dealers all understand it better. In the past, stray voltage problems may have existed which never were diagnosed.

To reduce the risk of stray voltage, Appleman recommends that

every dairyman have his electrical system examined and brought up to code requirements. In addition, dairyman building a new milking parlor should install an equipotential plane in the floor. That consists of wire mesh that bonds the floor and metal equipment together.

If your herd is having frequent health problems and you suspect stray voltage, contact your power supplier, a knowledgeable electrical contractor, or your county extension office. Stray voltage should be dealt with only by someone familiar with the problem, says Cloud. □

Path of least resistance can be rocky road for dairymen

Electricity commonly takes the path of least resistance to ground, and this simple tendency can be traced as one reason why some dairymen have problems with stray neutral voltage in their barns. But without electricity, dairymen would be at a loss. Almost every piece of equipment in a dairy barn is powered by electricity; lights, vacuum pumps, tank agitators, pipeline pumps, milking machines, and feeder augers.

Electric lines supply power through a primary circuit which contains a positive wire, negative wire, and neutral wire. Power from the main distribution line is routed into secondary lines that supply a farm, barn, or home with current. Ideally, any 'stray voltage' in the secondary neutral wire is supposed to be returned to earth through ground rods.

On most farms all neutral wires are connected (aside from the grounds) to return this voltage to a secondary neutral which in turn takes it back to the primary neutral at the power line transformer. But since many secondary circuits are fed by the primary circuit, with each one having its own grounds, the chances for a faulty ground are immense.

Unfortunately, cows are good conductors for voltage which cannot find a direct ground. They have four bare feet, often stand on wet concrete, have a lower resistance to electricity than humans, and are often in contact with metal items in barns (feeders, stanchions, grates, stalls, etc.) which can hold stray current. Contact with these items through moist membranes (nose, mouth, even milk in teats) complete the circuit when the voltage is there waiting to go to ground.

Research has documented that low frequency voltage (as little as .5 volts) can be felt by cattle; a charge that humans might not even notice. Dairy cattle are amazing in their capacity to deal

with stress, but left unchecked, the stress from daily contact with stray voltage can cause great harm.

Dr. Allan M. Britten, (a veterinarian in Ferndale, Washington) notes that voltage stress can cause mastitis flare-ups, high leucocyte counts, poor milk let-down, lower milk production, slow milking, and erratic (nervous) behavior in the parlor. Once exposed to such stress, the cattle may balk at entering the parlor where they know the stress originates.

One of the most common causes of stray voltage is poor wiring in barns and parlors. The high humidity in these environments is conducive to corrosion on electrical connections. Improper grounding, broken wires, and loose connections are the most common culprits.

In Wisconsin, dairy farmers have banded together and brought this problem to the attention of state ag officials, utility officials, milk equipment officials, and electricians. They have a stray voltage task force that helps farmers identify and isolate the problem so that a solution can be implemented.

Britten recommends that farmers who suspect this problem hire a certified master electrician to diagnose barn equipment with a volt and megahertz meter. To check a barn thoroughly, turn off the main power switch and check equipment; this cuts power to the barn except for any stray neutral voltage that may be leaking in from the primary source (power line). If stray voltage is found, it means the source is not in the barn.

Then turn the power switch back on and check again. If any increase in stray voltage is noted, it is coming from a source (circuit) in the barn.

If a stray voltage source is found there are several remedies that can be tried. The first, and most obvious, is to update any old, corroded, improperly

This, may mean deepening ground rods, or even bonding all metal fixtures together and providing a common ground.

A second solution is to have the power company install an 'isolator' (commonly called a 'knocker') at the power pole to open the bond between current on the power line and the farm service line. This costs between \$500-\$800 and should eliminate any outside source of neutral voltage leaking into farm circuits.

A third option is to install an electric ground system. This includes a monitor at the neutral bar of the farm service line which detects stray voltage and sends it to earth through a grid system of ground rods placed at least 300 feet from the structure. It can also prevent 'power spikes'; voltage surges commonly seen when electric motors in a barn are turned on. This solution requires regular maintenance, however, and carries a price tag of between \$4,000-\$6,000.

A fourth potential solution is installing an equipotential plane system in the barn; which can be done in two ways. One way is to groove the floor and bond all metal equipment together with copper wire and connect this to wire in the floor grooves. Another way is to install a wire-mesh ground grid under the floor and then bond all metal equipment to this grid. This won't ground stray voltage from off-farm sources, and cost estimates range from \$5,000-\$10,000 regardless of the option used.

Perhaps the simplest, and cheapest, way to combat stray voltage is bring all barn wiring up to code standards and keep a voltmeter handy in the barn for regular equipment tests. The meter should be able to detect voltages under one volt, however. A portable, hand-held meter costs about \$50-\$75. A stationary meter will accomplish the same purpose, but costs about \$200 (meter plus installa-

Stray Voltage

Boundaries, barriers, and beliefs.

Dr. Laurence Lalk is professor of sociology at Concordia College.

A Study on Electro-Magnetic Effects on the Health and Production of Dairy Cows, by Duane A. Dahlberg. St. Paul, MN: Minnesota Department of Agriculture. 1985.

Theory of Collective Behavior, by Neil J. Smelser. New York: Free Press of Glencoe. 1963.

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The scientific community often inhibits the investigative process so that persons needing information must turn to sources outside established science and develop their own alternative investigative networks. An example of this is the concern of persons in the dairy industry and health services about the effects of electromagnetic fields (EMFs) in both rural and urban settings in home and barn. Even though researchers and technicians in a variety of disciplines around the world are examining EMF effects, their findings are not adequately applied to perceived EMF problems. Dairy operators are gradually concluding that stray voltage causes problems as cattle show an unwillingness to enter barns, refuse to eat and drink, dance in the stalls, and kick their handlers. More serious problems attributed to stray voltage are spontaneous abortion, longer milking time, and general reduction in milk production causing serious economic consequences, according to a study done by Duane A. Dahlberg. Scientific and other community leaders have been slow in responding to such problems, either in establishing their validity or in helping define corrective action.

Sociology provides useful models in outlining how boundaries and barriers inhibit the investigative and corrective process. Neil J. Smelser's collective behavior mode identifies a number of points where problem solving becomes inhibited. It assumes that problem reduction occurs through a series of stages beginning with social conduciveness and concluding in corrective action. Each step is discussed relative to perceived problems with stray voltage.

1. *Social conduciveness.* Smelser's first conditional element, social conduciveness, asks whether there are direct restrictions on activities diminishing a specific problem. That is, can persons meet and discuss their common problems? Most Americans accept this as a basic right. Scientists and community leaders, however, feel that community and organizational identities limit their involvement in collective activities particularly if they are controversial.

2. *Social strain.* Smelser's second element exists when incompatible social demands simultaneously impose themselves. Dairyists are subject to a variety of strains including factors perceived to be related to stray voltage. Strains in academic and other research institutions limit interest and concern for problems outside their systems, such as in the dairy industry. Community leaders may perceive that pursuing unique interests leads away from concerns of their primary constituency.

3. *Generalized belief.* General knowledge about EMF effects is only gradually emerging among dairyists and academics. Research on EMFs is highly segmented and specialized, ranging from bird migration to a variety of human illnesses. Its relevance to the dairy barn is little understood by researchers, and an integrative consensus is limited by problem awareness, research idiosyncrasy, and institutional and national boundaries.

4. *Belief in negative effects.* Smelser suggests that effects must be perceived as negative to stimulate corrective action. There is no clear consensus about EMF effects, let alone specific negative effects. Amid ambiguous and sometimes inconsistent findings, community leaders and scientists are unable or unwilling to advise dairyists and health practitioners on corrective action.

5. *Researching EMF effects.* According to Smelser's model, a consensus about negative effects would lead to specific EMF research. However, funding constraints, alternative research interests, and methodological problems inhibit doing research specific to the dairy barn and related health problems. Persons who would profit most from corrective action do not have sufficient funds for adequate research (even when recognizing the need for it) or are not sufficiently organized to obtain funding from external sources.

6. *Research not applied.* Smelser's final stage is limited by inhibitors in the preceding steps. Some research is carried out, but it is seldom applied directly to dairy and other problems. Even when information is relevant, the language appears esoteric to persons outside the discipline.

Anecdotal and some scientific information is emerging to suggest that EMFs affect human health and behavior. We can ill afford short-circuiting the corrective process in human health as has occurred in the dairy barn.

—Laurence Lalk

Stray voltage, human health problems linked

By Dave Olson
STAFF WRITER

An associate professor at Concordia College says a new dairy farm survey indicates stray voltage may endanger humans.

□ Family's health problems parallel power line/B1

A survey of 389 dairy farms in Minnesota and 100 farms elsewhere in the country shows, for the first time, "a clear correlation" between stray voltage effects in cows and perceived health problems among humans, Duane Dahlberg said Wednesday at a news conference.

Dahlberg presented a report which he and Laurence Palk, a professor of sociology at Concordia, prepared jointly based on data and observations from farms across the country.

For the past 10 years, Dahlberg has been researching stray electrical currents and their effects on dairy cows. He said problems range from reduced milk output to cows dropping dead.

Dahlberg said that more needs to be done to determine what impact electrical currents and the electromagnetic fields (EMF) associated with them may have on humans.

Pockets of people who live near power lines or other places near strong electromagnetic fields have



DUANE DAHLBERG
Finds health danger to humans

been found to share a variety of ailments, he said.

Dahlberg said he believes the potential health problems from stray voltage and electromagnetic fields are equal to or possibly greater than the threat posed by chemicals, such as pesticides.

The new report cites survey data which Dahlberg said indicates at least one-third of the dairy farms in Wisconsin and Minnesota are affected by stray voltage.

"The 1992-93 survey attempts to ascertain if persons perceive if their household health problems tend to occur when they observe health problems among their cattle," The report said. "About thirty-one percent of the respondents (in the survey) indicate they noticed such an association."

The survey shows that about 31 percent of the respondents noticed household health problems when they observed health problems among their cattle.

The survey listed health symptoms possibly related to electromagnetic fields, such as numbness in the arms and legs, flu-like symptoms, fatigue, allergies and ear ringing.

One of Dahlberg's main concerns is with the amount of electricity transmitted through the ground as part of the country's power grid.

High electromagnetic field readings can be found in such household fixtures as water pipes, he said.

Bill Schwandt, director of the Moorhead Public Service Department, said his office typically gets about a dozen inquiries a year about electromagnetic fields. As media attention has increasingly focused on the issue, he said, public interest has also picked up. He said at least a dozen calls have

□ Danger
Back page, Column four

□ Danger

Continued from Page A1

come in within the past couple of months alone.

"We share the concern of the community as members of the community," Schwandt said. "We support all of the research that's going on out there."

Schwandt said the department has sent letters to its power customers summarizing the latest electromagnetic field research. Additional information is offered if people are interested, he said.

"We also provide EMP measurements if a customer requests that," Schwandt added. He said the measurements can show levels of magnetic field, but that "there's no conclusions that we can draw at this time" as to what the readings may mean.

Schwandt acknowledged there is electricity flowing in the ground, but just how much there is is hard to determine.

"Every home is grounded to the water system and that provides some return for the electric energy," he said. "The issue of where it (electricity) should be grounded, or if grounds should be used or not, is probably something that needs some further research," Schwandt said.

Isolation transformers: Not a recommended solution for stray voltage

Some Wisconsin farmers are contemplating the installation of an on-farm isolation transformer to eliminate their stray voltage concerns. However, Chuck DeNardo, Wisconsin Electric engineer, states that "in almost every case, an isolation transformer is an unnecessary expense that can greatly reduce the reliability and safety of a farm's electrical system."

"WE's Stray Voltage Reduction Program (see page 3) makes the installation of an isolation transformer unnecessary," said DeNardo. "WE works with its farm customers to reduce a farm's stray voltage to a level that does not effect herd health or production. WE and the customer accomplish this stray voltage reduction by implementing proven, reliable measures. If our investigation determines isolation from the utility system may be beneficial, WE will install a utility isolator, at no charge, until system changes can be made."

"Because of this program, the customer-installed isolation transformer serves no purpose."

Customers considering the installation of an isolation transformer should be familiar with the following issues.

Safety is compromised

The safety of the farm's electrical system may be affected by the installation of an isolation transformer. Protective devices such as circuit breakers and fuses often do not operate as well after the installation of an isolation transformer. This can increase the potential for shocks and fires, resulting from electrical faults.

"This device was never

intended for use on farms," said DeNardo. "It was designed and approved for commercial applications and power quality issues associated with computers and other electronic equipment, not to correct stray voltage."

Installation is complex as well. Electricians need to review more than 20 sections of the National Electric Code to ensure a safe installation.

"WE's Stray Voltage Reduction Program makes the installation of an isolation transformer unnecessary."

— Chuck DeNardo
WE engineer

"Many of the installations that have taken place were found to be in violation of the electrical code," said DeNardo. "This is dangerous and may put the farm, farm equipment and livestock at risk."

Equipment can be unreliable

The isolation transformer adds resistance to the farm wiring. Therefore, electrical equipment such as motors and lights won't work as efficiently. This increases the risk of motor burnout and equipment failure.

In addition, the transformer itself is susceptible to burnout or failure from lightning strikes and on-farm electrical faults. This could lead to expensive repairs and long power outages.

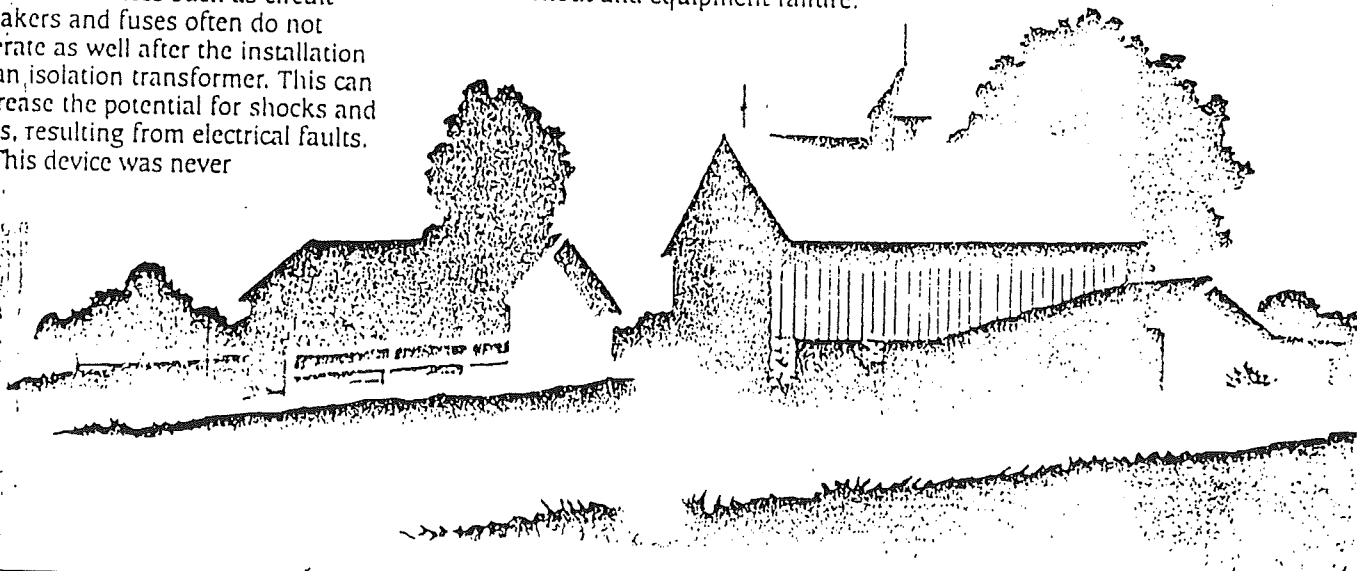
"Maintenance becomes the sole responsibility of the farm customer," noted DeNardo. "If a problem occurs, electricians may need to be hired and a new transformer may need to be ordered. If a transformer needs to be replaced, it could take weeks. The farm's operation could be greatly hindered."

It's a needless expense

An isolation transformer, that is properly installed, can cost several thousand dollars. "When WE already has safer, more reliable measures to reduce stray voltage, spending this money just doesn't make sense," said DeNardo.

The Public Service Commission of Wisconsin (PSCW) supports WE's position. They contend that the use of an isolation transformer is not necessary and does not recommend its use for stray voltage concerns "because in Wisconsin, their function is addressed by better, less costly (to the customer) methods."

(Continued on page 4)



Isolation transformers *(Continued from page 2)*

WE wants to help

It's important to note that the installation of this equipment will not qualify for WE's financial assistance program.

WE's Stray Voltage Reduction Program offers financial incentives to farm customers who implement approved on-farm stray voltage reduction measures. Qualifying measures include many on-farm

wiring changes, installation of an equipotential plane or an electronic grounding system.

"We strongly urge our customers to contact their local WE representative first," said DeNardo. "We're here to answer questions and help. Customers can give us a call anytime they believe stray voltage is a concern, and we'll conduct a free investigation."

See listing of WE offices above.

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Milwaukee, WI 53201-2046

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es generate static from Pennsylvanians



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ry. In Pennsylvania's York County, expresses her fears about the ill
er lines, on her family's farm late last month. She and her family,
proposed new electrical power line, are in opposition to the new line.
owned their farm since 1926.

Harrisburg, Pa. (AP)

Dairy farmer Curt Fogelsanger has heard the stories about magnetic fields from power lines — they cause cancer, seep into soil, contaminate crops and decrease property values.

His facts may be open to debate, but his fears aren't. And they're typical of the reaction utilities nationwide face when they propose new power lines.

In Pennsylvania, a plan to build a 268-mile line from Pittsburgh in the west to the eastern part of the state and New Jersey has generated much static.

The Public Utility Commission, which is reviewing the proposal for the 500-kilovolt line, has received 9,000 letters of opposition and 600 people have filed requests to intervene in the case.

Backers of the plan, proposed by General Public Utilities Corp. of Parsippany, N.J., and Duquesne Light Co. of Pittsburgh, say the \$600 million project would create much-needed jobs and meet demands for more energy. They have circulated a list of more than 200 unions and businesses supporting it.

Several studies have suggested in recent years that the risk of certain cancers, especially leukemia in children, might be raised by exposure to the invisible electric and magnetic force fields generated by power lines, appliances and everything electric.

"I don't know if they (magnetic fields) go into the crops, then the cows, then the milk, and who

**I don't know if they
(magnetic fields) go
into the crops, then
the cows, then the
milk, and who drinks
the milk? The kids.**

Curt Fogelsanger

drinks the milk? The kids," said Fogelsanger, whose 165-acre farm near Shippensburg is one of 2,000 privately owned pieces of property in the path of the proposed line.

"This is my mother's retirement package," he said. "Who's going to buy a farm with an electrical line on it?"

Utility officials say the power line will not add significantly to existing EMF exposure. Also, landowners would receive money for allowing the project to pass over their land.

For some, that's enough.

"I'd rather not have it over my property, but if I have to, I'll settle with them," Phares Nolt said from his 125-acre dairy farm near Shippensburg. "For farming, I don't think it's going to hurt much."

Pennsylvania already has 1,100 miles of 500-kilovolt transmission

lines. Why is this case drawing so much attention?

"I think the level of public understanding of EMFs is greater than it's ever been. There are more studies," said Susan Shannaman, a lawyer representing a group of opponents and a former chairwoman of the Public Utility Commission.

"It's a natural progression, just like with cigarette smoking. It wasn't until 20 to 30 years ago that people started talking about the impact," she said.

The situation is the same around the country.

►In the Washington, D.C., area, a 10-mile stretch of a 243-mile power line proposed by the Potomac Electric Power Co. was tied up in courts for 16 years before being approved earlier this year.

►A plan to build a 245-mile, 500-kilovolt line from Florida to Georgia recently was delayed by the Florida Power Corp. for four years because of "additional regulatory uncertainty."

►A 125-mile, 345-kilovolt line planned between Indiana and Michigan was opposed by a group of landowners who sued, saying the project wasn't necessary. The Michigan Public Service Commission has been asked to decide the case.

Nationwide, there are about 642,000 miles of overhead power lines of more than 22,000-volts compared with about 452,000 miles in 1970, according to the Edison Electric Institute, a utility trade association.

Farmer says stray voltage killed cows

Dairyman: Problem growing with more urban development

By GARY GUNDERSON
Agri News Staff Writer

ST. CLOUD, Minn. — There was a protest on the Joe Kenning farm south of here earlier this year.

There were no posters, picketers or speeches. Just the bloating carcasses of two cows Kenning said were killed in part by electro-

Additional stray voltage stories on A2.

magnetic energy that reached the animals through the ground.

Behind where the cows lay was a sign on a haywagon: "These cows were killed by electricity."

The cows collapsed in late February and died soon afterward. Blood and organ samples from the cows were sent to a laboratory, which could not find a cause of death, Kenning said. But the blood samples indicated that the animals were stressed.

Kenning said he thinks current carried by the grounding wire from the electrical system of a new house built nearby last August, coupled with existing earthbound electricity from the grounding wires of two power lines that pass near his house, are directly linked to the deaths.

A voltmeter Kenning installed in his barn showed that 30 percent more voltage reached his farm immediately after the house's electrical system was installed. The current gradually weakened the animals, he said, until they died.

Kenning has been documenting electromagnetic energy on his farm with a slew of meters, gauges and paper charts since 1979. High levels of electricity in the ground occur at the same time his cattle produce less milk or become ill, Kenning said.

The problems with electromagnetic energy seems to be getting worse, Kenning said, because more houses are being built near the farm, which means more current is going through the power line in front of his house.

"We can't keep this in the closet," Kenning said. "We have a serious problem here and we need the help of the public."

Duane Dahlberg, a physics professor at Concordia College in Moorhead, who has been studying problems with electromagnetic energy on farms for seven years, agrees with Kenning. He estimates that at least 20 percent to 40 percent of dairy farmers suffer from problems associated with electromagnetic energy.

Farms that seem to have problems with electricity in the ground tend to have lower production, premature cattle deaths, and human health problems, he said.

About 5,000 Minnesota dairy farmers have left the business since 1985. Many of these losses could have been due to problems with electromagnetic fields, Dahlberg said.



To protest what they feel is a problem with electromagnetic fields that are harming their dairy herd, Joe Kenning (right) and his

Midwest Region

Stray voltage may be jolting farmer

By GARY GUNDERSON
Agri News Staff Writer

ST. CLOUD, Minn. — Joe Kenning has a problem everyone acknowledges but nobody seems to be able to help.

The problem for Kenning, who owns a dairy farm about five miles south of St. Cloud, is stray voltage, he said. And the problem is getting worse because of residential construction in St. Augusta Township, a fast-developing area south of St. Cloud.

Kenning has asked the Stearns County Board of Commissioners to require developers to install electrical systems that don't put voltage into the ground. Without the help he will have to go out of business because of animal health problems and high somatic cell counts, which will render the milk unfit for sale, Kenning said.

"My cows give 13,000 pounds of milk, when a feed analysis said they should be giving at least 18,000 pounds," Kenning said. "If things don't get better, I might just as well sell out."

At an Aug. 13 meeting, the commissioners expressed sympathy for Kenning, but said they may not be able to require developers to upgrade their electrical hookups because there are no requirements to mitigate stray voltage in county development requirements.

The board tabled the matter, asking Kenning and Tim Bloch, who wants to develop four lots near Kenning's farm, to come up with an agreement within 90 days.

Kenning said he has paid thousands of dollars to have stray voltage mitigated on his farm and surrounding power lines, but every time a new house is built in the area he gets a fresh jolt of stray voltage. Kenning has employed an elaborate metering system on his farm since 1979 which documents that stray voltage on his farm increases whenever new homes are built or powerlines are moved, he said.

Kenning said he thinks it's unfair he has to pay to solve problems created by new residents and power companies, which essentially are causing stray voltage but do not compensate Kenning.

Kenning had many supporters at the meeting who testified on his behalf.

Duane Dahlberg, a physics professor at Concordia College in Moorhead, said stray voltage is a problem government officials and power companies must confront soon because it is harming the state's farmers.

Dahlberg has done extensive stray voltage research on Kenning's farm and elsewhere. The main cause of stray voltage, he said, are two-line power transmission systems where one line is used to transmit power and the other returns electricity back to its source. The return line is grounded for lightning strike and other mishaps, he said, and this allows electricity to get into the ground and travel through the earth because it is a good conductor.

More homes mean more grounded electrical systems and this means more stray voltage, Dahlberg said. But where stray voltage goes once it's in the ground cannot be predicted beforehand, because electricity can follow water courses, veins of mineral deposits and other geological features that

may not be readily apparent, he said.

"But I do know the more development in the area, the worse the problem will become," Dahlberg said. "If there's more development, he'll (Kenning) have to go out of business."

A solution to the problem would be a three-line system, with two transmission lines and the third being a non-current carrying grounded wire, Dahlberg said. But this would probably be expensive, Dahlberg said, and power companies have balked at putting in such systems for residential users.

Other dairy farmers who have problems similar to Kenning told commissioners that they need help.

"You people (government officials) are always talking about pollution," said Freeport dairy farmer Art Borgerding. "But there's nobody who pollutes more than power companies who dump stray voltage into the ground."

Said Dave Lusty, a Miltona dairy farmer, "We can't do anything about this on our farms. The power companies won't do anything, and

that's why we need help from people like you."

Representatives from power companies were not present to give their viewpoints on stray voltage.

Commissioners expressed sympathy for the farmers, but they don't know what they can

"I'm convinced there's something extraordinary going on with dairy farms in Stearns County, I don't know what we can do," said Rose Arnold, board chairwoman. "To stop developments, we need a good reason, but we don't have ordinances on this. I can agree with everything (the farmers) say but what can I do?"

Commissioners added it would not be fair to require new developments to contain stray voltage without penalizing established developments. Commissioners also said the matter may have to be resolved through state or federal laws.

"I think this board understands there's a problem," Arnold said, "but we don't know what sort of authority we have to do anything about this."

Electricity jolts dairy operation

By GARY GUNDERSON
Agri News Staff Writer

ST. CLOUD, Minn. — Electrical power did not reach the Joe Kenning farm here until 1949. Before then the farm used an electrical generator.

But soon after the power lines were installed, cows on the farm started to produce less milk and have massive outbreaks of mastitis, a problem that had been virtually unknown on the farm before that time, Kenning said.

For 30 years Kenning and his father, Norbert, struggled on, thinking their difficulties were caused by some sort of management problem. They sought advice from everyone they could find, but could never discover the silver bullet that would make their cows' production increase and death toll drop.

The cows were edgy and would have to be forced into the barn for milking, Kenning said. Milking was a slow process because the cows were often unwilling to let their milk down.

By 1979, the cows on Kenning's farm were producing only 11,000 pounds of milk a year. They called in a milking equipment salesman to watch them milk to see if they were doing anything wrong. The salesman suggested that Kenning check to see if electromagnetic energy could be the cause of their problems.

Taking the advice of the salesman, the Kennings installed a voltmeter and other measuring equipment. They soon discovered that there was a direct correlation between meter readings and milk production.

Stray voltage problem not limited to farmsteads

By GARY GUNDERSON
Agri News Staff Writer

ST. CLOUD, Minn. — Evidence indicates that electromagnetic problems are not limited to farms.

Before swimming pools can be used, they must be inspected to make sure pool occupants won't be shocked by electricity in the ground, according to Sig Nemeth, a former state electrical inspector. Chlorinated water is an excellent conductor of electricity, he said, and he's heard of cases where swimmers were shocked by electricity from a power line more than one-quarter of a mile away. If electricity is present, all metal near the pool must be grounded.

"This can be serious," he said. "There's been quite a few deaths in the

The voltmeter's readings vary widely, Kenning said. The meter's readings increase after 6 p.m. and on weekends and holidays because more people are home and using electricity, he speculated.

To protect the herd and people working on the farm, Kenning installed an isolation transformer in 1980, which prevents electricity from the power company's neutral wire from getting onto the farm.

But he said electricity was still filtering

United States because of this.

Preliminary results of a study by John Hopkins University indicates that exposure to electromagnetic fields from power lines can cause cancer and leukemia. The study found that telephone line workers exposed to the fields were twice as likely to develop cancer and seven times as likely to develop leukemia as other telephone workers.

Other research indicates that electromagnetic energy radiates strongly from power substations, electric blankets, microwave ovens and other electrical devices.

It's theorized that because electrical fields vibrate back and forth 60 times a second, the same to-and-fro movement may occur in human cells and possibly cause damage.

through. To combat this, in 1985 he built a non-neutral-to-earth system, which doesn't carry current but is grounded in case of lightning strikes.

Another positive step, he said, was Northern States Power Co.'s decision in 1984 to move a power line that formerly travelled 200 feet southeast of Kenning's barn. The power line now skirts the farm to the north.

But electromagnetic energy is still present in the ground, he said. So Kenning

built two special cow enclosures from old semi-truck trailers where he keeps all his calves and two or three cows. The trailers are five feet off the ground and insulated where they touch the earth with old truck tires and plastic foam.

Before using the trailers about three years ago, about 40 percent of the calves died and the survivors needed large amounts of medication, Kenning said. In the past two years, only one calf has died and the trailered cows produce one-third more milk than their earthbound herdmates.

Even with all these preventive measures, the production on the Kenning farm averages 13,000 pounds a cow, generally considered to be a poor performance. The average had been up to 14,000 pounds, Kenning said, but recent house construction in the area may have increased the amount of electricity flowing through the ground, Kenning said.

Based on the herd's genetics and feeding, Kenning's cows should be producing about 16,000 pounds of milk or more each, according to Jon Koeberl, livestock nutritionist with Farm Proved Feeds in Buffalo Lake. He has little doubt what causes the lack of production.

"The problems are probably strongly related to electromagnetic fields," Koeberl said.

"There's data that seems to say that if we put those cows down the road six miles that they would just take off."

Added Duane Dahlberg, a physics professor at Concordia College in Moorhead, who has conducted studies on Kenning's farm, "Electricity could be a big problem on that farm. With the records he's kept, it would be difficult to think otherwise unless you're biased."

Stray voltage destroys farmer's dairy herd

PLAINWELL, Mich. (AP) — In 1978, Paul VanDenBerg began noticing a drop in milk production at his successful dairy farm.

Soon after, many of his cows became sick and eventually died as VanDenBerg watched in frustration.

Only recently was he able to prove the cause: An electrical phenomenon called stray voltage that scientists believe may be zapping the livelihoods of many farmers.

In September, VanDenBerg and his wife, Judy, received a \$750,000 settlement from Consumers Power Co., which they sued in 1985, alleging that stray voltage was giving their cows shocks of varying intensity and causing stress, poor milk production and disease.

But more important to the couple than money, they say, is the affirmation it was stray voltage and not poor management that led to the decrease in milk production and the loss of 500 cows at their Allegan County farm.

"The farm game's been rough this year," VanDenBerg said. "We can survive the farm game, but we can't survive electrocution."

Stray voltage, a generic term for neutral-to-earth voltage, is a common phenomenon in most of the nation's utility systems that use the Earth as a conductor to return electrical power to its source.

Only recently has there been any scientific data to back up farmers' contentions that stray voltage can adversely affect livestock.

The VanDenBergs said they believe their dairy barn became part of the power-return loop to Consumers' substation because of a poorly placed and inadequately grounded transformer pole on their farm. When the cows came into the barn to eat, drink and be milked, they were jolted with shocks of varying intensity.

The jolts caused them to avoid eating and drinking properly, resulting in an immediate milk production drop and eventual sickness.

The stray-voltage issue has been baffling for farmers and utilities, said Alan M. Lescourt, a biomedical engineer at the U.S. Department of Agriculture's milk secretion laboratory.

"The utilities couldn't go anywhere and identify that this was

a problem," Lescourt said. "To have farmers saying their cows were affected by stray voltage was like saying flying saucers were affecting their cows."

When the VanDenBergs first noticed milk production problems in 1978, they replaced their milking system three times and hired several experts and electricians to help them pinpoint the source of their problem.

They suspected an electrical problem off the farm, but frequent inspections by Consumers always ended with the same finding: The problem is on the farm, probably poor management.

An ice storm in 1984 turned things around. Power was knocked out to the area and the family was forced to use a generator for seven days.

"Our milk production went up a

thousand pounds that week, and that's when we knew it wasn't us," VanDenBerg said.

Last month, as part of the settlement, Consumers told the VanDenBergs it would isolate their farm, putting them on their own power line.

The utility checks about 100 inquiries a year, and about half those complaints result in some corrective action, said Ronald L. Spees, a senior engineer at Consumers.

Last month, a Jackson County pork producer filed suit against the utility for \$500,000, alleging that stray voltage killed up to 1,000 of his hogs. Jon S. Fox alleges that electricity leaked into the ground, caused dehydration and stress among the hogs and caused them to avoid drinking. That case is pending.

stray voltage solutions, PSC rules

Utilities have to pay the cost of resolving stray voltage problems if the problems are caused by the utility's power lines, according to a new Wisconsin public service commission (PSC) ruling.

The ruling says that the dairy farm customers are not to be considered special needs customers, with the requirement that the farmer pay the cost of corrections.

If the utility is causing one-half volt or more of electricity in cow contact areas, it is the utility's responsibility to correct the problem and assume all of the costs for the corrections, according to the July 19 ruling.

The ruling clarified the commission's Jan. 18, 1989 order that defined stray voltage and set

guidelines for utilities to correct stray voltage caused by utilities' power lines.

However, utilities governed by the PSC interpreted the guidelines in different manners.

Complaints filed

Complaints were filed by farmers regarding Wisconsin Electric Power Co. (WEPCo.) procedures. Hearings on the complaints were held in Madison in February.

Stray voltage is electrical current that enters the ground and is picked up on metal objects that are grounded. On a dairy farm, cows can be affected by stray voltage and receive electric shocks in milking, feeding and water areas. The electrical impulses cause behavioral problems, herd health problems and reduced milk production.

If the stray voltage is coming from the utility's electrical system, the farm's electrical system can be isolated from the utility's system through the installation of a neutral isolator. An electrical grounding system (EGS) can also be installed to divert the voltage. Another correction method is equi-potential planes which can be installed to protect the cows.

WEPCo. has installed approximately 1,000 neutral isolators since 1981, said James Prothero, WEPCo. project engineer.

Until 1989, the utility had used one-half volt as the level at which it would install an isolator if the voltage was coming from the utility's lines. The isolator was installed at no cost to the farmer.

Change made

After the PSC order, the utility interpreted the order to read that

the "threshold of concern" was one volt. The company also decided that dairy farms were special needs customers who should be responsible for the cost of special services.

The utility would provide an isolator at no cost if stray voltage measured one volt or more. If less than one volt, farmers had to pay \$200 for a temporary six month installation or \$1,000 for permanent installation.

The utility also offered farmers up to \$1,000 for upgrading the on-farm electrical system, installing equi-potential planes or electronic groundings systems.

The average cost of an equi-potential plane is \$3,000 to \$4,000.

EGS systems cost about \$7,000 to \$9,000.

Major impact

The new PSC ruling will have a major impact on WEPCo. Not only must the utility bear the cost of installing a neutral isolator, if the one-half volt or more is caused by the utility's line. The isolator is considered only a temporary solution which should remain in place no longer than 90 days. Time extensions may be requested.

If the utility decides corrective action cannot be accomplished by upgrading the distribution line or other off-farm corrections, it can install on-farm mitigation devices, such as the EGS or equi-potential planes with the consent of the farmers.

Such on farm devices shall be owned, installed and maintained by the utility at no cost to the farmer, the ruling said. The cost can be included in the utility's rate

base.

The PSC ruled that no neutral isolator can be installed if less than one-half volt of electricity is measured in cow-contact areas.

New plan required

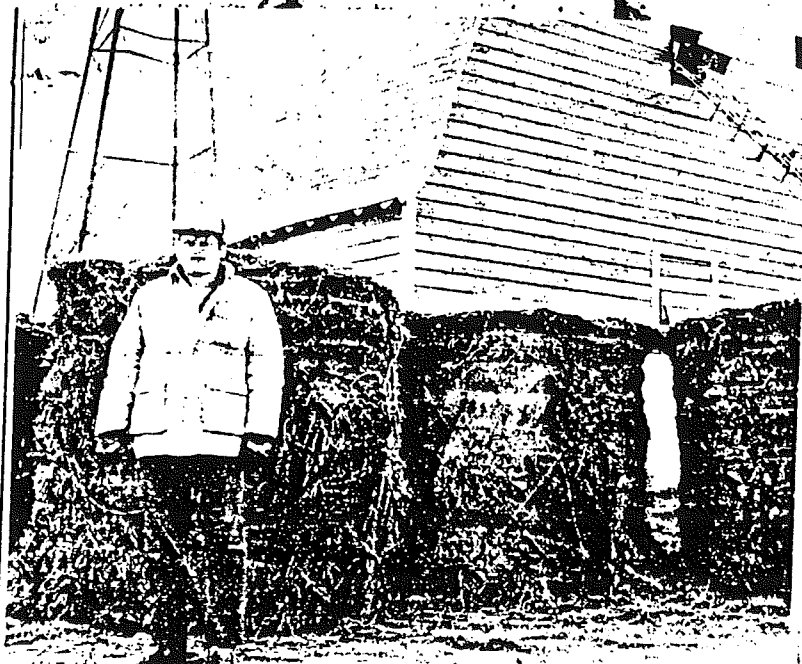
In addition, the PSC ruled that utilities must submit a plan within 90 days for reviewing existing isolator installations and conditions for removal.

To make sure that all farmers are treated equally, the PSC ordered the five major state utilities to develop a uniform tariff on

stray voltage neutral isolation for PSC approval.

Many of the complaints against WEPCo. came from Ozaukee County farmers, who have also requested a hearing on the utility's distribution lines in Ozaukee and Sheboygan counties.

About 75 Ozaukee County farmers and 45 from Sheboygan County have signed a petition asking the PSC to order the utility to upgrade its distribution system, said Wally Daggett, a member of the stray voltage task force.



Arvi Aho on his rural Wolf Lake dairy farm.

Local farmer traces production loss

by James Campbell

For Arvi Aho, the last two years have been frustrating.

Aho, a Wolf Lake area dairy farmer, watched the production of his 50-head dairy herd fall by about 25 percent since 1985.

That would be frustrating to anyone, but for Aho, the real frustration lies in the source of the production drop.

The cows are jumpy, according to Aho. They also have elevated somatic cell counts and have had reproduction problems. They slop the water out of their drinking cups and they swish their tails in a peculiar fashion.

But those are the symptoms of the problem, not the cause. For a long time, the cause of the problem eluded Aho.

He worked with his vet to track it down, looking for

anemia or a virus. Nothing was found.

He had the cows on a strict vaccination and testing program for several years, but the source of the problem was not uncovered.

At the same time the problem continued and got worse. Finally, Aho came to suspect stray voltage as part of his problem.

"I'm not going to say that it's all that, but we're looking at a 5,000-pound-per-cow drop in production."

Aho had always looked for another solution to the problem. When none was found, he suspected it was somehow his management ability that was causing the drop. But the problem seemed to come on too suddenly for that to be the case.

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"That which has worked before shouldn't really have one down that quick," he said.

But even now, after testing as confirmed the presence of stray voltage, Aho has doubts about how big of an impact it is his current problems.

"I guess that's the problem how do you really say that's what it is? But then again, there are obvious problems with production and we've tried all sorts of other things...and we really haven't seen a response."

Two years ago, Aho was having his best year in the dairy business. His herd was producing an average of 20,300 pounds of milk per cow, with 10 pounds of butter fat.

"There's really no comparison now," Aho said of the herd's present production, which is around 15,000 to 16,000 pounds.

Production began to slide and the cows began to act differently. Stray voltage was suspected at that time, but a test conducted by Lake Region Electric Cooperative (Aho's power supplier) concluded that stray voltage was not the problem.

Aho looked for other answers, finding no solutions, eventually took another look at stray voltage. He called John Gagnon, an electrician who worked extensively with stray voltage situations. Using

a computer, Gagnon runs an extensive test to try and find if stray voltage is present, and if it is causing a problem.

In the course of the testing, Gagnon found .7 to .8 volts present in the barn. Additional potential of 1 volt present in some parts of the barn made for a total voltage of 1.7 to 1.8 volts.

According to some authorities, .5 volts is the threshold level which will begin causing problems for dairy cattle.

It seemed to be enough to cause problems for Aho's herd. In addition to the decreased production, the health of the cows deteriorated.

Their somatic cell counts — a measure of the cow's general condition — went up, indicating the cows were under stress.

They had problems with reproduction. It was more difficult to get the cows pregnant and, once they were, there were more premature births and abortions.

"I guess we're looking at a sort of uneasiness. The cows seem to be reacting to something and it seems like a lot of times we have production differences between each pickup."

Sometimes that difference was as large as 200 pounds from one milking to another.

"Which is not a good thing. It

really shouldn't be that big."

But with the confirmation of stray voltage as the problem following Gagnon's analysis, things began to get better.

"Just the awareness of the problem was itself a help because I could do some things to try to alleviate the problem during milking."

"What we started doing is that I'm running as few things as possible during milking."

Reducing the electrical load on the farm during milking is a method for minimizing the electrical potential reaching the cows.

"It seemed like it helped, but the change may not seem real obvious."

But knowing that the problem was at least partially related to stray voltage was also a big help in reducing the stress to Aho. When it was confirmed, it reduced the doubt that had haunted him from the onset of the problem.

In addition to confirming stray voltage as the problem, Gagnon also recommended an isolation transformer be installed at the farm.

In very simple terms, an isolation transformer is a device which, when installed on a farm, prevents voltages on the neutral line of the power distribution system from causing problems on the farm.

After conducting their own test at the farm, Lake Region Power installed an isolation transformer at Aho's farm last month. It was put in on a trial basis for four to six months.

After the transformer was installed, power company personnel told Aho that the phone line appeared to be contributing to the problem. They recommended that the phone company install their

own ground to take care of the problem.

Aho contacted the company. After some defensiveness, they said they would be able to install ground.

Aho said Lake Region was also quite defensive the issue when he first contacted them. Aho understood that reaction from the company.

"I suppose they're in a situation where people are suing them for these kinds of things."

But that's not what interested him. Through the whole process, Aho has been more interested in getting the problem solved than pointing fingers.

While it might be easy to pin it all on the suppliers, Aho says that's not the solution.

"We can't do that. Using the electricity, is obviously not completely the problem. But I do think we need to be more willing to do our part. Obviously there are things you can do."

Besides, he points out, battling over the issue is going to solve the problem.

Aho says it's too soon to tell if the isolation transformer helped the situation. But the things seem to look good.

"I think it looks better. That's my observation," he said, noting that the cows seem to be acting normal now.

If the isolation transformer alleviates the problem on Aho's farm, he will have to pay the \$400 to \$500 cost of the transformer.

"It's quite a cost, but it costs to lose 5,000 pounds of production per cow."

"I'm sure that if it helps at a small price to pay."

Panel to look at stray voltage effects

St. Paul, Minn. (AP)

A state commission's decision to study effects of stray electrical voltage may have come too late to help farmers whose dairy herds already are affected, a farmer said Friday.

"What about farmers who don't have time to wait for research?" Douglas County dairy farmer David Lusty asked the commission. He said he noticed a 30 percent increase in milk production since he detected and fixed a stray voltage problem in 1985.

"Four years later, we sold 16,000 pounds (of milk) per cow, up from 2,000 pounds," said Lusty, the farmers' unofficial spokesman. "That made a tremendous difference."

Stray voltage is errant electricity

that enters the ground from grounded electrical distribution systems. The problem was recognized by researchers in several nations as early as the 1940s. They cited health dangers from current that flowed through the ground, into barns and into the bodies of cows and dairy farmers.

Attention to the issue increased after a Sibley County jury awarded \$1 million in damages on Oct. 9 to a south-central Minnesota farm family who sued Northern States Power Co., claiming their cows' milk production dropped because of stray electrical voltage. The family also said NSP failed to bring it under control once it was discovered.

State officials said Friday they lacked information about stray

voltage, but plan to begin studying it.

"Before we decide how to move ahead, we should know what we are dealing with," said Mike Michaud, an engineer with the Minnesota Public Utilities Commission.

Friday's meeting included officials from the PUC, the Department of Agriculture, the Department of Health, the Department of Public Service, the Environmental Quality Board and others. Officials from these agencies make up the commission appointed by Gov. Rudy Perpich to study stray voltage.

The group agreed to comb utility company records to categorize complaints from customers about the severity of the problem. "There is a sense of urgency because

some farmers have had the problem over a number of years," said George Durfee, a physicist with the Environmental Quality Board.

Durfee said the commission's study would take two months to complete.

The only survey on stray voltage is 5 years old. Agriculture Department specialist Bill Coleman said the results of that study are not valid because the state has lost farmers since then.

Lusty delivered a report from Duane Dahlberg, a physics professor at Concordia College in Moorhead, which said that between 20 percent and 40 percent of the dairy farms in Minnesota and Wisconsin are affected by stray voltage.

Farmers want action on stray voltage

By GARY GUNDERSON

Agri News Staff Writer

ST. CLOUD, Minn. — Bob Imdieke wants to see something done about stray voltage.

A dairy farmer near Elrosa in western Stearns County, Imdieke said his herd is being decimated by stray voltage from a power line near his farm.

He said his cows often perform a motion like a dance to keep at least one of their feet off the ground because they are seeking relief from shocks. This stresses the animals and causes premature death, he said.

"We can't continue this way," he said. "We lose half our cows a year."

Imdieke may not have to wait long be-

fore hearing what the state government thinks about stray voltage. He and other farmers, clergy and others concerned with stray voltage testified to a committee that will make recommendations to Gov. Arne Carlson.

The meeting, held in St. Cloud on March 11, gave people a chance to express their concerns about stray voltage, said Mike Michaud, a staff member for the Public Utilities Commission.

Michaud is a member of the yet-un-named committee that will make its recommendations to Carlson. The committee includes people from the state Department of Agriculture and other state agencies.

The group will make recommendations to Carlson on what to do about stray voltage within one or two months, Michaud said. After receiving the report, it's up to

Carlson to come up with solutions on programs to help people who may be harmed by stray voltage.

People testifying at the meeting had varying views of what should be done to rectify stray voltage problems, ranging from rebuilding the country's electrical distribution system to lowering punitive damages so power companies would not be afraid to acknowledge that stray voltage is a problem.

Others complained about what they see as a lack of cooperation from the University of Minnesota and power companies.

John Varner, a dairy farmer from Montrose, said he had stray voltage problems on his farm until he installed an electrical isolator. The power company was willing to supply the isolator, but only if Varner signed a three-page document that would

absolve the power company from any legal liability.

Varner hasn't signed the document yet on the advice of his attorney.

The agreement would require Varner to carry insurance covering damages from stray voltage.

"I can't blame the power company for trying to cover their tracks on this," Varner said, "but I think they should supply me with electricity without stray voltage, and if they can't do that they shouldn't make me pay so it doesn't."

Dave Lusty, a dairy farmer from Mil-tona, said the University of Minnesota has ignored doing more research on stray voltage, even though there has been evidence. See STRAY A2.

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dence of its existence for decades.

"Where's the cooperation?" Lusty asked. "They've been playing around on this for years and haven't helped us a bit. We can't sit around and wonder what's going on."

Part of the problem in isolating where stray voltage comes from is that it has many sources, said Duane Dahlberg, a physics professor from Concordia College in Moorhead who has extensively studied stray voltage on farms.

Stray voltage has two main sources, energy radiating from power lines and current carried in the ground, Dahlberg said. Most stray voltage problems are caused by current in the ground. Modern electrical transmission lines have two wires, one for transporting power to the user and the other to return power to the source to complete the circuit.

Electrical current gets into the ground because the return wire is grounded in case of lightning strike or other mishap, Dahlberg said. This allows at least 40 per-

cent of the return power to enter the ground.

Electricity in the ground can be carried long distances because the earth is a good conductor, Dahlberg said. This electricity enters the bodies of humans and animals through concrete floors, metal pipes and other fixtures that pick up the power from the ground.

Dahlberg said stray voltage may be causing extensive damage to human and animal health. The potential for problems isn't limited to the strength of shocks, he said. Evidence indicates that numerous low-level shocks could be more dangerous to health than single, strong shocks.

Power companies agree there's electrical current in the ground, but the companies say farmers who have production or cow health problems are bad managers, not victims of stray voltage, said Spark Burmaster, an electrical engineer from Chaseburg, Wis., who has worked with farmers struggling with stray voltage.

Power companies blame farm mismanagement because acknowledging th-

stray voltage could be causing problems for farmers will open the industry to a flood of litigation, Burmaster said. Concerns about legal problems are not limited to farmers, because stray voltage could also be causing health problems for urban-ites. The problems now seen on farms could be the tip of the iceberg, he said.

"Farmers are just like canaries in the mine," Burmaster said. "The same thing could be happening in the cities, but farmers have known about it first."

Jim Kaster, a Minneapolis attorney who helped win a \$1 million stray voltage lawsuit against Northern States Power for dairy farmers Dale and Gloria Zumberg of Green Isle, said the state should set allowable limits for stray voltage.

A state-mandated limit would protect farmers who may be damaged by stray voltage but don't have the evidence or a large enough potential damage award to interest lawyers, Kaster said.

"Lawsuits aren't problem solvers," Kaster said. "In many cases, it's the state's

place to establish standards. We can obtain compensation, but the legal system can't solve the problem for everyone."

Burmaster disagreed with setting standards, noting that little is known about what levels and frequency of shock are dangerous to animals and humans. If a standard was set, those falling just below the limits could be having problems with their animals but have no legal recourse.

A better solution would be to limit punitive damages for farmers plagued by stray voltage, Burmaster said. This would allow power companies to acknowledge there is a stray voltage problem and possibly prompt them to work on solutions without exposing themselves to huge damage awards.

This sort of cooperation between power companies and farmers is the only way stray voltage problems can be resolved, Burmaster said, because farmers can solve the electrical problems on their farms, such as faulty wiring, but still have stray voltage problems from off-farm sources.

The Milwaukee Journal Farmers face invisible villain as stray voltage harms cows

By ELIZABETH CULOTTA
of The Journal staff

When Wally Daggett's dairy cows take a drink, they may receive small electric shocks.

Excess electricity called stray voltage finds its way into metal drinking cups and milking equipment at Daggett's dairy farm near Random Lake. The stray voltage has caused his 200 dairy cows to become nervous, drink too little water and even develop bleeding ulcers and udder infections.

Daggett received more than \$1 million from Wisconsin Electric Power Co. in a 1984 judgment after filing suit in Sheboygan County. Since then, a handful of other dairy farmers have sued the utility over stray voltage and won, or settled out-of-court for substantial sums.

And for the first time, the state budget passed by the Legislature Thursday includes \$188,800 to educate farmers about stray voltage, said a spokesman for the amendment's sponsor, Rep. Barbara Gromelus (D-Buffalo).

The problem is that utility wiring systems were designed for humans, and cows can feel lower levels of electricity than humans can, said Ron Legro, public information officer for Wisconsin Electric. "It's a real problem for us," he said, "frustrating, subtle and hard to detect."

Stray voltage on a farm can mean decreased milk production, loss of stock and economic hardship for farmers. Hundreds or even thousands of Wisconsin dairy farmers may have the mysterious problem, according to officials of the State Department of Agriculture, Trade and Consumer Protection.

At this point, no one knows how much production is lost because of stray voltage, how many farms are affected, or how much it might cost to keep electricity away from cows.

Up to 25% of milk production may be lost on an afflicted farm, according to Bob Ehert, executive assistant at the agriculture department.

To protect prize-winning cows brought to the State Fair in August, concerned state officials have ordered inspections of electric wiring to detect any stray voltage at State Fair Park in West Allis.

Stray voltage is found "everywhere there is electricity," said James Prothero, an engineer with Wisconsin Electric. The excess voltage is the normal consequence of moving electricity through power lines, he said.

Ironically, the electricity gets to the cows because of a safety feature,

explained Robert Appleman of the department of agricultural engineering at the University of Minnesota. Small amounts of electricity normally bleed off high-voltage lines or electrical equipment into grounding wires designed to carry excess electricity. For safety in case of lightning or short circuits, the grounding wires are hooked into the cow's motorized milking equipment and metal drinking cups.

Stray voltage becomes a problem when extra current surges along grounding wires, seeking the path of least resistance — often a cow. A variety of poor wiring conditions on a farm or in utility power lines may send electricity coursing into a barn, utility officials say.

However, farms plagued by stray voltage often are served by power lines identical to those of farms without stray voltage problems, according to Wisconsin Electric's Legro. Engineers also do not understand why certain areas, like Random Lake, are hotbeds of stray voltage. "From the utility's point of view, there's no difference there," Legro said.

When cows receive small shocks from their drinking cups or milking equipment, they may drink less and they may give less milk. After steady exposure to stray voltage for six months, chronic udder infections may mean that a "cow will never make money again [and] you might as well sell her," Daggett said.

Exactly how much stray voltage is too much for a cow is unknown; anything from one-half to two volts or more may be considered dangerous, according to farmers and state officials. Humans can feel electricity at about four volts.

Pigs are even more susceptible to voltage than cows are, Legro said, but pigs generally do not touch metal objects in the barn. So most complaints have come from dairy farmers, he said.

To tackle the problem, the agriculture department last year created a Stray Voltage Task Force composed of farmers, including Daggett; utility officials; and representatives of the agriculture department and the state's Public Service Commission.

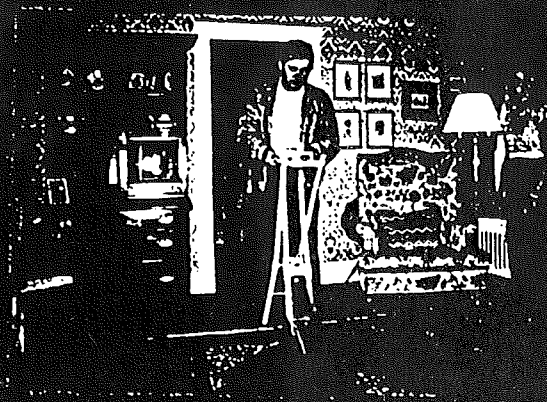
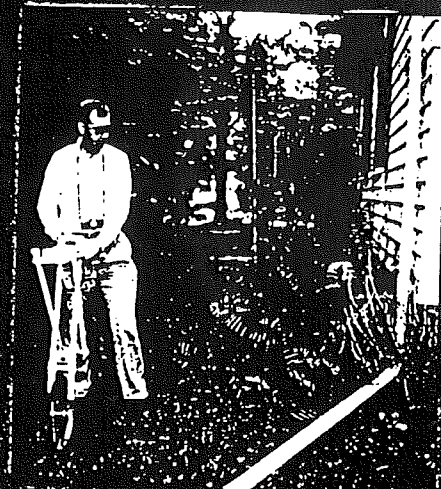
The combined task force created a Stray Voltage Attack Team to research the problem. Ten Wisconsin dairy farms were chosen as research sites to explore sources, solutions and preventive measures. More than 100 farmers volunteered to work with the team.

Their research report, due in early August, will offer strategies to combat stray voltage and suggest who should pay the costs, according to PSC member George Edgar.

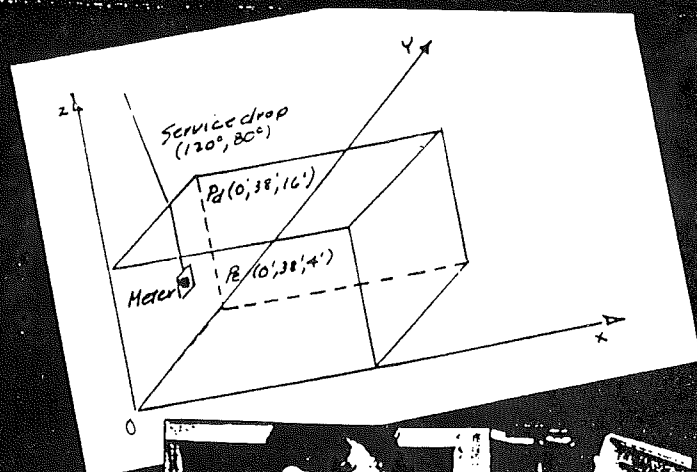
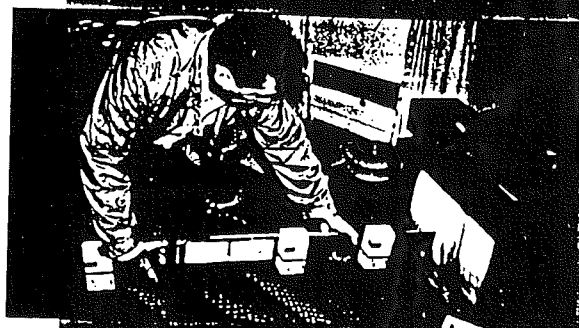
Remedies for stray voltage vary widely in cost and sophistication. To install a sheet of metal across the entire barn floor to prevent electricity from traveling through cows costs about \$5,000, a small sum compared with the cost of milk production and stock losses, Daggett said. But to replace two miles of power line, Wisconsin Electric must spend more than \$50,000. Wisconsin Electric representatives declined to reveal how much it will cost the utility to replace the entire distribution line to Daggett's farm.

Although stray voltage can be reduced, it cannot be eliminated, utility officials emphasize. When fighting stray voltage, "You can't do it once and wash your hands of it. You have to keep monitoring," agreed Ehert of the agriculture department.

Daggett thinks that 95% of stray voltage problems can be overcome. But he says that even after installing \$7,500 worth of new electrical equipment, he lost 23 cows to stray voltage last spring. Wisconsin Electric crews work at his farm "just about every week now," trying to rid his barn of stray voltage.



HOW MEASUREMENTS WERE MADE The 1000-home survey protocol included several types of measurements to produce a robust accounting of residential magnetic fields. To record the spatial distribution of fields, a stand-alone recorder called STAR was mounted on a calibrated VANA surveying instrument and guided along a grid pattern both inside and outside the residence. Sketches of the two environments were made to indicate the position of field sources, such as appliances, distribution lines, and service drops. Fields from operating appliances were measured separately, using three STAR instruments attached to a support at distances of 1, 2, and 4 feet. And four STARS were left in the residence for 24 hours to determine how fields changed over time. After all the measurements were made, data from the recorders were downloaded into a computer for documentation and analysis.



CASE 101

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production, began at 17,500 and dropped to 13,200
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts, rose to over 1,000,000
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among un milked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

Dog has stiff joints

Dog becomes skittish at different points of property

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs

1st, 2nd, and 3rd person frequent headaches

1st, 2nd, and 3rd person frequent flu-like or cold symptoms

1st, 2nd, and 3rd person vision problems (e.g., blurred or heavy eyelids)

3rd person problems with breathing

1st, 2nd, and 3rd person excessive fatigue

1st, 2nd, and 3rd person frequent irritability

1st, 2nd, and 3rd person often feeling under stress

1st, 2nd, and 3rd person weakness and pain in legs

1st, 2nd, and 3rd person forgetfulness

1st, 2nd, and 3rd person allergies

1st, 2nd, and 3rd person ears ringing

1st, 2nd, and 3rd person pressure behind the eyes

1st, 2nd, and 3rd person unexplained nausea

1st, 2nd, and 3rd person unexplained general feeling of not being well

1st, 2nd, and 3rd person rheumatoid arthritis

2nd person (female) feeling bloated/retaining body fluids

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm was designed to handle at least 100 cows in tie stalls with all of the necessary auxiliary equipment. It is a modern operation and barn conditions are very satisfactory. The ventilation is excellent maintaining adequate fresh air for the cows. Bed rock is at distance of 10 to 15 feet on the farm. Therefore, the water table is high within a few feet of the ground surface. Water was standing in a number of natural ponds on the farm.

Electrically there exists a substation approximately 300 meters West of the farm, a 115 KV AC transmission line less than 100 meters South of the barn and two transmission lines North of the farm. One of the transmission lines is a 230 KV AC line about 300 meters from the farm and the other is a larger line about 500 meters from the farm. The transmission lines are over much of the pasture area of the farm. The transformer for the farm is on a pole about 50 m from the barn. No isolation device is used on the farm. A telecommunications antenna is at the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

- Unusual failure rate for incandescent bulbs
- Unusually high rate of battery failures
- Radio and TV failures not related to lightening storms
- Increasing motor burnouts
- Occasional shocks from water lines and faucets
- Noisy telephone
- Unexplained fluctuation in electric bills.

HISTORICAL BACKGROUND

This farm family had operated dairy farms for a number of years. They began their own dairy operation in about 1985. Throughout their involvement in the dairy business, they had been very successful. At the time of moving to their present location they were able to bring approximately 150 head of dairy cows and young stock all of which they owned.

The previous owner of the farm in question had an excellent dairy operation through the 1970's with an 18,000 to 20,000 pound rolling herd average milk production. Information provided indicated that in the 1980's the previous owner began to have problems with his cows. The rolling herd average dropped to approximately 11,000 pounds and cattle that were severely crippled were being hauled from the farm on a regular basis. The substation was built in the 1970's

Since moving to the farm in 1991, they have lost over 150 dairy cows either because they died on the farm or they were unable to function as dairy cows. Young stock would not grow at a normal rate, calves would die even when housed in hutches, milk production was much lower than on their previous farms, and the cattle suffered from many different health problems. No veterinarian has been able to find any way to stop the cattle losses nor restore milk production. The farm family has tried many different methods and contacted experts to determine what was wrong in their dairy operation. The only positive assistance came when the issue of stray voltage was dealt with. Many measurements were made on the farm. AC voltages were measured on the farm and in the barn.

MEASUREMENTS

A survey of the 60 Hz magnetic fields on the farm indicated a general background of approximately 1 milligauss (mg). South of the barn there was a region where the background field was between 2 and 3 mg. Measurements were made at many locations both at a height of one meter above the ground and at the surface of the earth. The currents on the transmission lines are responsible for the majority of the 60 Hz magnetic fields measured on the farm. The 60 Hz magnetic fields ranged from 35 mg under the transmission line to the South of the farm to 60 mg under the 230 KV line and 45 mg under the largest transmission line. All of these lines would be inducing currents into the ground on the farm because all 60 Hz magnetic fields induce 60 Hz electric currents in conducting materials. During the milking operation unbalanced currents in the grounding system were producing significant 60 Hz magnetic fields in the regions of the cows. The variations were large ranging between 1.5 to 10 mg. At other times, even with the farm electricity turned off, currents in neutral wires, ground wires, and water lines would produce magnetic fields in the barn that were above the background magnetic fields of 1.0 to 2.0 mg.

The currents in the water pipes were in the range 30 to 50 milliamperes (ma). Other conducting materials in the barn carried smaller electric currents. With the electricity to the farm turned off, a current of 400 ma was measured on the neutral wire. At some locations in the barn the 60 Hz magnetic fields were higher near the floor than at one meter above the floor. With the EGS system off the AC magnetic fields were only slightly different. While the farm electricity was off, voltage measurements were made. Voltages ranged from 0.32 VAC between the water cup and the floor in front of the cows with the major component being 180 Hz, 0.34 VAC between water line and floor and 0.67 VAC between the milk line and the floor. These voltages were nearly the same with the power on and the EGS off. With the EGS on these measurements ranged from 0.12 to 0.07 VAC

The EGS system had a grounding grid in the pasture West of the farm and ground rods on both the East and West sides of the barn. With the electricity off on the farm there was from 3.2 to 4.0 VAC between the grounding grid and the farm neutral and approximately 3.0 VAC between the grounding grid and one of the sets of ground rods near the barn. When connecting the grounding grid to the neutral, a current of nearly 1 ampere (1000 ma) was in that wire. For the connection of the grounding grid with one of the sets of ground rods near the barn 400 ma was in the connecting wire.

The voltage between the neutral and ground rods on either side of the barn ranged from 0.70 to 0.82 VAC when the EGS system was off and about 0.010 VAC when the EGS system was on. The current in the earth made neutral to earth measurements vary from one reference point to another. Voltages ranging from 0.8 to 4.2 AC were common. DC was also present between all earth connections and in the barn but no attempt was made to identify values for specific locations.

When the EGS was off stanchion to stanchion voltages was 0.165 VAC and the short circuit current was 0.36 mA. From the pipeline to the stanchion there was 0.300 VAC and a short circuit current of 2.05 mA. Between the water cup and floor there was a voltage of 0.226 VAC and a short circuit current of 0.56 mA and between the panel ground and stanchion 0.250 VAC and a short circuit current of 0.109 mA. When the EGS was on stanchion to stanchion voltage was 0.045 VAC and a short circuit current of 200 mA, pipeline to stanchion was 0.078 VAC and 392 mA, water cup to floor was 0.007 VAC and 0.016 mA and panel ground to stanchion was 0.056 VAC and 45 mA.

A natural gas pipeline was buried about two miles from the farm. By measuring the magnetic field above the pipeline and estimating the distance to the center of the pipeline in the ground, it is determined that from 2-5 amperes of 60 Hz current were on the pipeline.

MITIGATION

The voltages in the barn that could cause electricity to shock the cows were below those projected by the university experts to effect health and production. In spite of the voltage levels an electronic grounding system (EGS) was installed on the farm. The EGS system is designed only to prevent the cows from becoming shocked while in the barn. This is accomplished by "neutralizing" the neutral to barn floor voltage. A grounding grid is established between the farm and the substation that is expected to carry the electric current away from the farm and to the substation. As indicated by measurements in the barn, voltages decreased and short circuit currents increased except for the water cup to floor. This system is based on the assumption that return current on the primary travels through the earth. The records substantiate that the EGS system is helping. For example, milk production for the dairy herd had dropped from 20,000 pounds RHA to 12,000 before the installation of the EGS. Since then, milk production has increased to 18,000 pounds. The loss of livestock and other health problems continue, however

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

If the EGS system is left off for one-half to one hour the cattle began to show a greater restlessness and discomfort in the barn. The operation of the EGS system does benefit the cows. Most of the cows appeared to have urination problems, bulging eyes and a general appearance of being under severe stress. The manure appeared hard and glassy. Neither the farm operators nor others in the barn could bring their hands near the cows without getting a reaction of distress from the cows. There appeared to be no contentment among the cows and very few chewing their cud.

CONCLUSIONS

There is a serious behavioral, health and production problem for the cows on this farm.

The problems, symptoms and effects are characteristic of stray voltage farms.

The major source of currents in the ground that can affect the cows is from off the farm. The fact that there is no isolation of the secondary neutral from the primary neutral on the farm, the 400 ma in the ground wires entering the barn will distribute itself on all conductors in the barn that are in some way connected to the earth. Since the 400 ma must originate on the primary system, it is connected to the substation through the earth. This electricity is always in the conducting components of the dairy barn whether or not any electricity is used on the farm. The existence of greater AC magnetic fields at floor level or ground level compared with one meter above implies that there were currents in the earth or in the floor of the barn.

Because of the locations of the transmission lines around the farm and the substation to the West, these must be the major sources of the electricity in the ground and the 115 KV transmission line is the major source of 60 Hz magnetic fields on the farm.

The fact that a ground fault on dairy farms puts electricity in the earth and accepted in the dairy industry to cause the set of effects experienced on this farm, the only conclusion that can be drawn, is that the electricity going into the ground from the electric utility system is the primary cause of the problems for the dairy cows.

The closeness to the large sources of electricity and the electrical conditions on the farm should call into question the use of this farm as a dairy farm unless the electricity in the earth is eliminated and the transmission lines are moved. When cows are affected as they are on this farm, it probably is not a healthy place for people to live either.

The readings of voltages and short circuit currents in the cow contact areas when the EGS was off and on present a very confusing picture of electricity and need to be investigated.

CASE 102

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tarnish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person frequent headaches
1st person frequent flu-like or cold symptoms
1st person vision problems (e.g., blurred or heavy eyelids)
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
2nd person allergies
2nd person neurological illness (e.g., Multiple Sclerosis)
2nd person ears ringing
2nd person pressure behind the eyes
1st person unexplained nausea
1st person unexplained general feeling of not being well
2nd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
2nd person (female) problems with menstrual cycle
2nd person occurrence of heart related ailments
Human and animal symptoms happen within the same time frame
Father treated regularly for heart problems

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm is located in a relatively low area with a high water table. A parlor system is used for milking the cows. The transformer pole is in the center of the yard. Calves are housed in hutches away from the barn. The well is within 35 meters of the primary and secondary grounds. A natural gas pipeline is within 600 m of the farm.

ELECTRICAL EFFECTS ON THE FARM

This farm experienced excessive incandescent lamp failures, occasional shocks from water lines or faucets, noisy telephone requiring frequent service calls, accelerated corrosion of well casings and other buried pipes and unexplained fluctuations in electric bills.

HISTORICAL BACKGROUND

The owner of the farm has lived on the farm all of his life and is involved in the breeding of superior lines of dairy cattle. The problems presented began in about 1988 and continued to get worse. A considerable effort was devoted to attempting to determine the cause of the problems. Numerous specialists and experts were brought in to study the dairy operation in an attempt to solve the problems. They installed a new milking parlor in the summer of 1992 and yet the problems persisted. The farm was isolated December 19, 1992, resulting in a significant improvement in all aspects of the dairy herd. The problems returned in January. Between the time of isolation and the effects the farm had experienced substantial precipitation. In the isolation installation, the secondary ground was located 3 m from the primary ground in a low area sometimes filled with water. In September 1993 the secondary ground was moved to a location which on higher ground and about 15 m from the primary ground. Since that time, the dairy cows have improved and the conditions experienced before isolation have not returned.

MEASUREMENTS

The 60 Hz magnetic field was about 0.05 mg in all areas of the farm. SN to reference ranged between 0.030 VAC and 0.33 VAC. PN to reference rod ranged from 0.80 to 4.2 VAC. The ranges for these numbers were according to the location of the reference, the time of day and with the isolator functioning. Approximately 100 mA AC were on the primary grounding wire when the farm was turned off. With the neutrals connected and the isolator bypassed, the PN to reference ground decreased by a factor of two compared with the separation of the neutrals. 2000 mA AC were measured on the wire connecting the two neutrals that would be the current from the primary neutral going into the farm grounding system. A large portion of that current went through the barn. In the barn, measurements between the cow contact points and the reference were in the range of 0.03 VAC with no power and from 0.1 to 0.3 VAC with full power. When the isolator was bypassed, cow contact points to reference were in the range of 0.3 VAC with no power and from 0.6 to 1.1 VAC with full power. DC levels at cow contact points and between cow contact points and reference ranged from 0.3 to 0.9 VDC. The highest were under full power, isolator bypassed and to reference.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

The initial isolation had the primary and secondary grounds separated by about 3 m. The benefits of isolation lasted only until the ground became saturated with water. The secondary ground was then moved to a dryer location 15 m from the primary. The herd improvement associated with isolation returned after the moving of the ground rod.

MITIGATION

Installing the isolator brought about a significant improvement in the behavior, health and production of the cows.

OBSERVATIONS AND CONCLUSIONS

Even after isolation the problem is not completely solved. Cows are still not healthy. In the year since isolation there have been a number of stillborn calves and some birth defects. The average age of the cows is 42-44 months now and at one time it was around 60 months.

There appeared to be no AC on the natural gas pipeline.

CASE 103

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

GOATS

Behavior

Poor water consumption
Stiff hind legs; difficulty walking

Production

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Poor hair coat, yellow in appearance
Immune system failures
Eye infections

KIDS

Have poor survival rate
Unable to grow at normal rate
Birth defects

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Kittens dying, small thin heads
Cats leave farm and die

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs
1st, 2nd, and 3rd person frequent headaches
1st, 2nd, and 3rd person frequent flu-like or cold symptoms
1st, 2nd, and 3rd person vision problems (e.g., blurred or heavy eyelids)
1st person problems with breathing
1st, 2nd, and 3rd person excessive fatigue
1st, 2nd, and 3rd person frequent irritability
1st, 2nd, and 3rd person often feeling under stress
1st, 2nd, and 3rd person weakness and pain in legs
1st, 2nd, and 3rd person forgetfulness
1st, 2nd, and 3rd person allergies
1st, 2nd, and 3rd person ears ringing

1st, 2nd, and 3rd person pressure behind the eyes
1st, 2nd, and 3rd person unexplained nausea
1st, 2nd, and 3rd person unexplained general feeling of not being well
1st person (female) feeling bloated/retaining body fluids,
Bladder problems
1st person tumors

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm layout is provided in the diagram

HISTORICAL BACKGROUND

The family purchased the home and established the farm activities in the locations shown in the diagram after the transmission line was operational. A problem was caused for the family by high levels of carbon monoxide which could have separately been responsible for the types of health effects described by the family. Information from dairy farms suggests that these effects are also caused by electromagnetic (EM) energies. The presence of the transmission line through the farm certainly requires consideration of the potential effects from the EM energy. Medical records are available for the people since moving into the home. The documented effects on the goats and cats that do not live in the house but near the line are similar to the stray voltage problems on dairy farms,

MEASUREMENTS

The results of the measurements are presented on the enclosed drawing. Measurements were repeated at the locations shown, under different conditions and at different times. The variations in the numbers obtained at different times of measurement showed some changes in AC magnetic field. No trend was observed, however. The changes in the fields measured were probably related to load changes on the transmission line. Turning the power off in the home resulted in no measurable difference in the measured values of AC magnetic field, but it did show a significant decrease in the AC fields measured at ceiling found on the wall and ceiling surfaces on the main level of the home. The conclusions are that the AC magnetic fields in the home are almost totally due to direct radiation from the transmission line and the electric fields at the wall and ceiling surfaces on the main level of the home are caused by AC current induced in the solid material of the home which comes from radiated energy from the transmission line.

AC electric field measurements at surfaces are important because of providing information concerning induced AC energy and/or electric currents in the solid parts of the building as well as indicating AC field gradients in the regions of surfaces. In the work with which I have been involved, there appears to be a connection between health problems and the presence of AC energy, especially in the floors of buildings or in the ground. This is preliminary work, however.

A digital multimeter and an oscilloscope were used to measure and observe the electrical energy in the grounding components of the home. No well defined 60 Hz signal was observed. The signal appeared at times as an 180 Hz wave which is probably the result of the electricity in the ground from the three phase transmission line. In addition, associated with grounded system, an rf signal with a carrier frequency of 1 mHz came through quite strongly. Multimeter measurement provided information on the presence of direct currents in the grounded system. Without more careful analyses, one must simply say that direct currents are present and that the neutral-ground has a negative potential with respect to the earth. The sources and the real magnitudes cannot be determined.

OBSERVATIONS AND CONCLUSIONS

This case provides an opportunity to compare the specific problems associated primarily with proximity to a transmission line with farms at long distances from transmission lines.

CASE 104

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs
Cattle pressing their heads against each other
Cows dropping to concrete
Cows jumping through the stalls

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts, always higher than 600,000
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among un milked heifers)
Stress rings on hoofs (excessive growth)
Heifers and cows having trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failure resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loss hair

PETS

Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Cats just won't stay on the farm

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person frequent flu-like or cold symptoms
1st person vision problems (e.g., blurred or heavy eyelids)
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
1st person ears ringing
1st person pressure behind the eyes
1st person unexplained nausea
1st person unexplained general feeling of not being well
1st person (female) feeling bloated/retaining body fluids
1st person (female) problems with menstrual cycle
1st person having an illness that medical professionals cannot diagnose
Soft swelling under right arm

GENERAL INFORMATION

FARM CHARACTERISTICS

This farm is located a quarter mile from a lake. The ground is marshy and wet, with water standing in a number of natural ponds on the farm. The farm is surrounded by woods.

Electrically there are major transmission lines 1 mile from the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure
Radio and TV set failure (non-lightning related)
Occasional shocks from water lines or faucets
Noisy telephone requiring frequent service calls or having false rings
Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

This farm family has operated this dairy farm for a number of years. They have lived on this farm since 1970. Symptoms and effects characteristic of stray voltage farms have been observed since 1991.

MEASUREMENTS

Maximum primary neutral to earth voltage: 8.0 VAC
Minimum primary neutral to earth voltage: 8.0 VAC
Maximum secondary neutral to earth voltage: 4.0 VAC
Minimum secondary neutral to earth voltage: .02 VAC

Cow contact voltages and contact points between drinking cup and ground floor were: 7.5 VAC
With the power shut off there was a measurement of 4.0 VAC between the drinking cup and floor

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Change in electrical wiring made on farm: rewired well
Utility added power on line built in 1947 without upgrading
Changes in livestock and people -- have effects listed above
Many changes in electrical equipment as well: fluctuation of lights and vacuum pump, numerous DC motor burnouts -- noted documentation of cause being from power surge

SPECIFIC CHANGES IN NEUTRAL GROUNDING

Change in primary neutral with isolator
Currents were present in grounding wires in the barn when the power to the secondary circuits was disconnected and increased by a factor 25 when the primary and secondary neutrals were connected. In addition with no wire connection between the primary and secondary neutrals, currents would increase on the grounding wires in the barn and the secondary neutral voltage would rise when 240 volt loads were turned on in the barn.

MITIGATION

Installation of isolator by power company made no difference to problem on farm. Animals got shocks bad enough to knock them down in their stalls. The isolation system at the transformer pole isolated the utility and farm neutral for primary neutral voltages of less than 24 volts and was operating as designed.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

Even with the farms electrical system functioning appropriately and indications of professionally done electrical work, there are electrical problems demonstrated through the discomfort and restlessness and sudden death of the cows.

CONCLUSIONS

There is a serious behavioral, health and production problem for the cows on this farm.

The problems, symptoms and effects are characteristic of stray voltage farms.

Since there are many grounds on the primary system and the earth is carrying 65 to 75% of the return-neutral current in the utility electrical system, other utility grounding will also contribute to the currents present in the barn floor, other parts of the barn, and the earth on the farm. Measurements that will identify sources are nearly impossible unless entire substations can be disconnected and all grounds can be disconnected.

The only logical cause for the sudden death of the five cows in the barn is electrical. For such an event to occur at random locations throughout the barn, an external and a very energetic source of electricity must have passed through the floor in the stalls, unless the cows had been drinking water when the electricity passed through the only connection to the farm neutral is the tie chain. If the primary neutral voltage had surpassed the 24 volt limit of the isolator, the isolator could have momentarily connected the primary and secondary neutral. A voltage of that magnitude on the primary neutral would imply a malfunctioning of the utility electrical system or at least a significant increase in current into the earth. If such an event had occurred, the current going onto the secondary neutral would have been approximately 6000 mA much of which would have reached the stall areas of the barn. The facts that neither farm operators felt anything and they were both in contact with the gutter chain,

would suggest that the current came directly through the earth to the floor of the barn. Certainly such an event must be thoroughly investigated in order that dairy farmers are not required to live with fear of the event re-occurring.

Measurements of 60 Hz magnetic fields on the farm revealed that in the home people were exposed to approximately 0.1 to 0.2 mg from the distribution line along the road by the farm. The fact that the distribution line produced that large a field at that distance from the line implies an imbalance between the current on the high voltage wire and the current on the neutral wire. An imbalance results because current on the neutral side is returning to the substation directly through the earth.

CASE 105

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
Excessive teeth found in feeders and feedbunk

CALVES

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats
Cats leave farm and die

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person forgetfulness

1st person ears ringing
1st person high incidence of non-malignant body tumors
1st person occurrence of malignant body tumors

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm family owns two farms that are in close proximity of each other. There is a wetland approximately 300 m East of the barn where the cows are milked and the pens where the milking cows are housed. A high water table exists throughout the farm. Two natural gas pipelines pass through the farm. One of the lines is along the road on the West side of the barn and the other goes through pens holding milk cows. A television cable is on some of the electric distribution poles West of the barn and is buried in the ground from the transformer pole South. Along the first road going East, South of the barn is another connection to the cable television.

ELECTRICAL EFFECT ON THE FARM

Noted were:

Unusually high rate of battery failure
Increasing motor burnouts
Occasional shocks from water lines or faucets
Noisy telephone requiring frequent service calls or having false rings
Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

MEASUREMENTS

At the surface of the earth directly over the natural gas pipelines the 60 Hz magnetic field from the alternating current (AC) power frequency ranged between 1 and 2.5 milligauss (mg). If the center of the pipeline were 1.0 m below the surface of the earth, the approximate current on the pipeline would be in the range of 0.5 to 1.2 amperes(A)AC. The 60 Hz magnetic field reading at the surface of the earth over the television cable was approximately 25 mg. No determination was made of the nature of the current on the cable. The magnitude of the current would be approximately 6 A AC., if one assumes the cable to be buried at a depth of 0.5 m. It would be especially important to perform a study analyzing the extent to which the currents carried on these underground conductors are reaching the barn and areas where the cows were housed and milked. Information should also be provided by the cable television and the natural gas pipeline companies concerning the cathodic protection used for these buried conductors. If active cathodic protection is used, the farm family should be informed as to what quantities of direct currents (DC) might be reaching their barn.

With the electricity turned off in the barn, voltages in the range of 0.15 VAC and from 0.060 to 0.30 VDC were measured in the barn at the cow contact points and from 0.20 to 0.30 VAC and 0.060 to 0.30 VDC with the electricity on. Adding a 240 VAC load showed little change in the measurements in the barn. With no electricity being used in the barn, there was no observable AC on the water pipes. During evening milking, the voltage between the metal on the transfer jar and the floor varied between 0.45 and 0.55 VAC. Sufficient current was in this circuit so as to not be caused by induction. The voltage increased by a few percent whenever the transfer pump was on. Since the transfer pump operates on 240 VAC, the source of the observed increase in this area of the barn is most likely from current reaching the earth on the utility grounds. The DC tended to oscillate by a few percent. Measurements of the ambient 60 Hz magnetic fields were made with both the barn's electric power off and on. The levels in the barn changed slightly as the electricity was turned on and off in the barn.

Adding electrical loads had only a small effect on these readings. The range was between 0.2 and 0.25 mg. The largest values were always near the lowest floor in the milking parlor. There is no clear evidence that provides specific information concerning the source except that the measurements indicate that the currents are mainly horizontal in direction and in the earth. Using the coil from the milligauss meter and a battery powered oscilloscope, the structure of the current causing the measured magnetic field could be studied. The observed signal revealed a general 60 Hz structure with more of a triangular shape with some higher frequency structure in the troughs and peaks. In addition there was a few percent of radio frequencies appearing. The triangular shape implies the presence of some odd harmonics in the current.

While milking an experiment was performed for information purposes. A Fluke 87 multimeter was connected between the metal bolted to the floor and the claw of the milker. The measured voltage was in the range of 0.1 to 0.2 VAC. When the meter was switched so that it measured direct currents, the cow responded within a few seconds by quickly moving as if to escape something. The response from the cow only occurred when the meter was set to measure direct currents. When the meter was disconnected or measuring the voltage no response occurred. This experiment was repeated a number of times with the same response each time. The electrical difference for the cow is the high impedance of the meter when measuring voltage and low impedance when measuring current. Since there was a voltage difference between the floor of the barn and the milker claw, a significantly greater current would be in the circuit of the meter when measuring current compared with measuring voltage. Even though the current path was through the milk from the claw to the teats, the cow was connected to another electric circuit by which addition current would be passing through the cow. When measuring current with a digital multimeter, the impedance of the meter is sufficiently low to be considered a short circuit between the two connections. Therefore, it would be similar to connecting the floor directly to the claw of the milker. This experiment would at least indicate that one cow is sensitive to the small currents experienced in connecting to the floor upon which the cow was standing.

There were both AC and DC voltages between the old and new wells. The readings were 0.17 volts and 1.2 ma DC and 0.015 volts and 0.20 ma AC. The old well had no connection to either the farm neutral or the farm grounding systems. Both wells were West of the barn, within a few meters of each other and both into the same aquifer.

Some measurements were made to determine approximately the quantities of electric currents that would have accessed the farm grounding system before isolation. Connecting a multimeter between the primary and secondary neutrals at the transformer pole at the farm where the cattle were milked revealed a range of from 0.3 to 2.7 VAC. The potential alternating currents that would have gone from the primary neutral line onto the farm grounding system ranged from 250 to 2000 ma. The potential DC ranged from 12 to 15 ma. The lowest values were measured at about 3 pm during low power use on the distribution line, the highest values were measured at about 5 pm after milking had started and the overall electric use on the line had increased. These currents would enter the farm grounding system if the farm were not isolated. Once the currents from the utility neutral are on the farm grounding system it will eventually reach the earth and return through the earth to the substation. Between the two neutrals at the farm where the young stock were housed, the voltage between the primary and secondary neutrals was 2.5 VAC. Approximately 300 to 400 ma AC and 15 ma DC would be expected to go into the farm grounding system if the farm were not isolated. With the meter connected between a waterer which is connected to the well only by a plastic pipe and a ground rod approximately 1 meter away, 0.020 VAC, 0.12 VDC, 0.2 ma AC and 1.2 ma DC were measured. Since neither of these is connected to a neutral and no electricity was being used on the farm these measurements tell one that outside sources of electricity are present in the ground on the farm.

Along the road South of the farm buildings the television cable again surfaces. Connecting between the ground of the cable and a steel fence post about 5 meters from the cable ground there was an electrical potential of between 2.5 and 2.7 VAC. The fence post would allow from 300 to 400 ma to go into the

earth from the cable. The utility neutral of the electrical system was at 1.2 VAC with respect to the same steel post.

MITIGATION

The cows had stress marks on their hooves and many cows had hooves that were curled forward and deformed. They had distended eyes as if under a great deal of stress. Some cows had fatty tumors, leg ulcers and uneven udders. Before isolation all of these conditions were far more severe. In addition, mastitis was nearly out of control and the SCC had risen to 1,500,000. Also before isolation the farm family observed innumerable health problems from apparently minor conditions such as tough hides and mummification of the hides of dead animals to the death of a young bull in the pens on the farm. The bull appeared to explode with blood emanating from both ends of the animal. After isolation, conditions improved. SCC decreased to approximately 400,000, milk production increased and the survival rate for calves has increased. At the farm where the young stock were housed, cattle were considerably healthier.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

Observations of the actions and responses of the cows in the dairy barn reveal a sensitivity of the cows to some adverse stimulus which is both continually present in the barn and also intermittently occurring. The effects are observed in stalls where the only cow contacts are the hooves of the cows as they stand on the floor of the barn. The overall well being of the animals degrades in a direct relationship to the time spent in the barn. In the floor of the barn and in all conducting members in the barn there are both DC and AC electric currents present. Small electric and magnetic fields are also present throughout the cow's environment. Electricity is determined to be reaching the barn from sources independent of the farm electrical system. The pathway is through the earth. The cows electrical environment is effected by both AC and DC emanating from the earth. Measurements show that significant alternating and direct currents are entering and leaving the earth by means of the primary and secondary grounding systems.

CONCLUSIONS

There is a serious behavioral, health and production problem for the cows on this farm.

The problems, symptoms and effects are characteristic of stray voltage farms.

On this farm an electrical environment for cows results from the 60 Hz magnetic fields caused by currents in various conducting media in the earth as well as the distribution lines and the currents in the earth which result from the use of the earth as a current carrying conductor in electrical distribution.

Measurements in the barn with electricity on and off reveal that during non milking times, the main sources of fields and currents are off the farm.

The measurements between the separated primary and secondary neutrals indicate that up to 2 A AC and 15 mADC would be going into the secondary grounding system without isolation. These currents are then present in all materials in the barn that conduct electricity including the dairy cows and the people working in the barn. Because they are from the electric utility circuits, these currents must connect through the earth back to the substation. The pipelines and cables in the earth through and around the farm provide conduits for the utility currents from other sources which adds to the load of currents in the earth. Because of the number of carriers of electricity in the earth as well as the earth, itself, with a high water content, this farm family has no means for preventing the current from reaching

the cows. Isolation stops only the current reaching the cows from the utility neutral but cannot control the currents on the other conductors and in the earth.

CASE 106

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems

Health

Multiple or recurring mastitis (not responding to treatment)
High veterinarian bills
Inability to maintain weight
Heifers and cows have trouble getting up
Difficulty in birthing

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate

HUMAN HEALTH

High levels of stress
Allergies
Cancerous eye tumor
Skin cancer
Psychiatric problems

GENERAL INFORMATION

FARM CHARACTERISTICS

In the summer and fall of 1980, new phone and electric lines were brought in and placed underground. A new well was drilled, and buildings were added to and remodeled. The farm's Grade B dairy operation was upgraded to Grade A.

The farm was the last service on a feeder line. In the surrounding 3-5 mile radius and except for an occasional dairy farm all farms are isolated from the utility. State docket requires that a neighboring farmer should be notified when a farm is isolated; the farmer never was.

The electric company has installed a pad-mount transformer near the barn foundation with a concentric cable (the utility's primary neutral is exposed to the outside of the cable) buried from the utility's distribution system.

Prior to checking the water in the tank, the utility reps were convinced that this was strictly an on-farm problem because they had found two blots in a splash guard which held the metal water line in place where powdering was very evidently breaking the bonding. In the opinion of the Coordinator of the Farm Mediation and Arbitration Program for the Department of Agriculture, the utility reps were looking at the effect and not the cause of the problem - their primary neutral.

The utility's distribution system is very old -- most likely over fifty years. Down the road from the farmer is a ground wire broken off lapping in the wind. The poles are quite weather beaten.

HISTORICAL BACKGROUND

In 1980 the farmer built a milking parlor setup (on an equipotential plane as recommended to prevent stray voltage problems) for 125 cows milking three times a day. The farmer worked up to 86 cows and when things did not seem to be working, he cut back, hoping to again work toward the goal. By the time the farm was isolated the farmer was only milking 40 cows.

When the farmer installed the parlor in 1980 he was told there would probably be some older cows that just would not adjust from milking in a flat barn to the milking parlor. They might not milk out or they might kick a lot. The automatic detachers might not work on them and the farmer should consider using the units on manual for these cows to make certain they milked out. If they continued to have a problem making the transition the farmer should plan to cull them.

The automatic detachers seemed to work. But then the farmer had some mastitis problems and more and more he was using the units on manual, and machine stripping, defeating the purpose (and high cost) of the automatic units.

It seems there was a pattern developing to the farmer's troubles. For a time he was calving year round and his milk production was pretty steady from month to month. Then it changed and after a time the cows and heifers were being bred after they were away from the barn, feed bunk, waterer in the yard, and out on the pasture or in a feed lot. By putting the heifers and dry cows out to pasture they would gain weight and the heifers would come into heat. So the farmer started running two bulls: one with the heifers and another with the cows. Cows were being bred after they were in a feed lot with green chop on a wagon rather than eating from the bunk in the yard. They, too, gained weight and milked better during the summer months. If the farmer tried to confine them near the barn, they would leave feed in the bunk and break out to get to the other feed.

The farmer was having great difficulty with his cattle birthing and then the calves surviving. #78 was first bred October 8, 1981. The means she probably calved in July of 1982. The cow could not even get up even though it did not have calving problems. So the farmer put her on a stone boat and brought her up onto the lawn. There, in the shade, she was fed, milked, watered, and pampered. Meanwhile, she grew very thin and thrashed around. The farmer rolled her from side to side and propped her up with bales. The vets could not find anything wrong with the cow and said to let her die. Eventually she put on weight and was in good shape.

It was not long before the same thing happened again and again. Only #78 survived. All of the others died. Vets did not have an answer, but possibly a pulled muscle or nerve damage from calving. Why did this suddenly start when the farmer never had problems like this before?

Over the years the farmer continued to have cows die. As time went by, they died sooner. Some had nice healthy calves before they died, but others had a 'funny' calf that seemed weak and also could not get up.

Some time after this, the farmer began his experience with the "mystery disease." Like the downed cattle, this struck mostly newly fresh animals, both cows and heifers. They would be milking nicely, then suddenly stop, going nearly dry for a few days. Then they would come back, but not up to the amount of milk they were producing before the "mystery disease" hit. Again the vets had no answer. Having them out for calls like this only cost the farmer money -- money he could not afford to spend.

At some point the farmer began having problems with calves. They held their head funny, their tongues hung out the side of their mouths, they couldn't stand, nor could they suck. Some appeared to be deformed. Others died within a day or two for no apparent reason even though they appeared to be healthy at birth.

There were mysterious deaths -- calves, heifers, and cows. No one had answers. Some suggested heart attacks or even cancer.

After a time there was a problem with catching heats and getting cattle bred. Some cows did not seem to breed so the farmer started running a bull. Finally the farmer could not afford to pay the AI bills, and he was not getting good healthy calves, so he gave up on AI and went totally with a bull.

The farmer has a double six milking parlor with a PEP. The PEP was installed in 1980 at the recommendation of his dairy equipment people.

In the number three milking parlor where these bolts were arcing, the cows would kick violently as most likely they were receiving shocks when they urinated or manured in the parlor, as these bolts were placed where they could catch it on the splash guard. The cows were not only being shocked while they drank water from the tank but also when the farmer was using the water hose to wash off the cows' udders during milking.

Over the years the farmer began seeing tumors and wart-like growths on teats. As time went by the farmer seemed to have good luck raising those calves that lived and were healthy. He built super hutches where the cattle could be grouped outside until they were older. The cattle grew well and did well in the hutches or out on the pasture. Then in the fall, the farmer would move the bred heifers and dry cows to a loafing area attached to the barn where they ate from the same feed bunk the cows ate from. Then they were confined and had to eat from the bunk, drink at the water tank in the yard, and sleep in the loose housing area. In water the farmer's cattle seemed to lose weight. There were also more weak and dying calves. Some animals aborted or had mummified fetuses.

In 1988 the farm was effected by the drought, and the farmer cut back on his herd. He began to start milking three times a day and mastitis and udder problems improved. Then in the winter the cattle began to lose weight.

The farmer began renting other farms and working more land to raise feed to build up the herd. He tried DHIA, balanced feed rations, feed supplements, building up, cutting back, different vets, herd health programs (from Jan. 1980 to Feb. 1987), different AI technicians, bulls, and a variety of teat dips. The farmer trimmed hoofs so the cattle would be more comfortable and able to walk better. He fed in the parlor, in the bunk, along the fenceline, and in the barn. By the summer of 1992, when feed was short due to lack of rain, the farmer instituted more grazing along the lines of Intensive Rotational Grazing. That seemed to help. SCC was down, cows milked, gained weight, and looked good. Then, on Feb. 5, 1993 the farmer was told he had a stray voltage problem. A few days later he had to call a well drilling company because of leaking water pipes in the milkhouse. The corrosion in the water pipes was caused by

electricity such as stray voltage. An expert agreed with these findings. He said the farmer's water pipes were deteriorating in half of their expected lifetime.

The farmer was isolated on June 11, 1993. In the summer of 1993 he expanded the grazing, but the cows with mastitis problems would not clear up. The farmer eliminated those cows. He also could not get corn planted and finally settled for planting sudan/sorghum/soybeans for in the silo. This grew to record heights but this past winter it did not produce milk or body energy like corn would have. So now the farmer was again experiencing reduced milk production due to lack of quality feed. In addition, he could not afford to buy the quality he should have.

On July 13, 1983, a stray voltage meter was installed in the farmer's parlor. The needle always jumped back and forth a bit. According to the material put out by the utilities, a volt and a half or so was not anything to be concerned about. Furthermore, the farmer demanded that everything in the parlor be grounded just as he was advised to do. The electric company had brought in all new underground wiring and all the motors and equipment were brand new.

The farmer had a Sales & Service Company making monthly visits to check and replace anything that needed to be replaced and to bring cleaning products. (Later the farmer could not pay the bills anymore so they stopped coming.) The farmer quit DHIA since he had the meters that told how much milk a cow was giving. The farmer thought the extra meters that were attached for testing might be causing a problem with reduced vacuum as he was having more and more mastitis problems and the automatic detachers were coming off before the cows milked out. Also the cows kicked off the units before they were done. This could be caused by a vacuum problem from the meters.

For a time in the early 1980's the farmer used a mechanized cleaner with a tank and a rotating brush and a sanitizer/cleaner in the water. The brush massaged and cleaned the udder. The farmer then used paper towels for drying. Over the years he had previously used water, no water, paper towels, cloth towels, pre and post dipping, and a spray bottle so as not to convey a disease problem from one cow to another via a dipper. None of it worked. Every time the mastitis seemed to disappear, it would reappear. The farmer tried Oxytocin and different cow treatments, as well as different mastitis treatments. Still the problem came back with some cows barely putting a drop of milk in the bulk tank through an entire lactation. The farmer could not afford to call the vet for everything, so he culled some cows and replaced them with other purchased cows, trying to build a better herd.

Then the farmer started getting sick. At first his illness was blamed on stress caused by the problems with cattle and finances. He was diagnosed with possible terminal cancer and the diagnosis was changed to a possible allergy. The farmer would get a tiny fluid filled pimple that would itch and open up. Then it would ooze and get larger and ugly looking. Some would become infected. Later they would scab over and then go away. Another one would pop up in another place. Most of them were on skin that was exposed in the parlor or when working outside. A few were under his shirt sleeves. In spite of medication, it then became a problem in the winter months too. Then it was blamed on dry hay and possibly the leaves in the hay. At times it got better, then worse again.

Then the farmer had a nervous breakdown and underwent months of psychiatric care. In late 1992 he had surgery for a tumor on his eye and another diagnosis of cancer, this time a minor skin cancer. The farmer ended up at Mayo Clinic.

On July 11, 1993, the farm was isolated. By the middle of July the farmer's symptoms were gone and they never returned. In December 1993 he quit taking allergy medication and has not had another sore to this date. He has also gained weight and now looks better than he has in years even though he is still under a lot of stress due to the financial situation. The farmer continues to go to Mayo Clinic for evaluations and there are no signs of any more problems with his eye.

Most of the farmer's cows and heifers calve during the half of the year. Nearly half of those calving between January 1 and July 1, 1993, either died or had to be sold due to mastitis, tumors, and other health problems. Several of their calves died or were born dead. In 1980 the farmer remodeled to milk 125 cows. On January 1, 1994, the farmer had 41 milk cows left with a number of them dry.

Of the animals calving between July 1 and December 31, 1993, (after the farm was isolated), only one gave birth to a dead calf. Not one calf died after birth. The calves could stand up, walk, drink milk, and eat, unlike many born before the farm was isolated. Not one cow or heifer died in that time period. The farmer filed Chapter 12 bankruptcy to keep his farm. It was approved in July 1993. As a result he has not savings, credit cards, or charge accounts, nor can he borrow money without permission from the bankruptcy trustee or court. All feed, seed, fertilizer, veterinary visits, machinery repair, fuel, etc., is paid immediately or he will not get the product or service. The farmer did not receive his spring planting loan last spring, but then corn was not the best crop. At least he got a silo full of feed from the sudan/sorghum/soybean mix. The farm loans were written down with unsecured amounts written off by order of the bankruptcy court. There are a few other bills in the hands of the bankruptcy trustee and these will be paid by the farmer with any money left after secured bills are paid. The farmer is allowed a specified amount for living expenses and has a financial plan for farm expenses.

MEASUREMENTS

The levels of stray voltage in the milking parlor range from .14 volts steady state to a high of .560 steady state using a 500 ohm resistor. The high was when the farm was loaded with only 240 volt equipment although there was a minimal amount of 110 volt equipment being used to start some of the 240 volt equipment. The incoming service panel at the side of the barn was running a balanced load at the time of the testing also. During this test there were over 250 milliamps flowing on the neutral system with the A and B phases balanced, so this indicated there had to be current going to earth somewhere on this farm. Upon further investigation the voltage was determined above level of concern in the feed bunk area.

At the feed bunk area .460 volts were measured with the farm shut off. This meant total utility contribution. As the 240 volt load to the system was added, the voltage increased to over 1.420 volts steady state. This is utility contribution to the farm that the farmer has no control over. When the wiring was first installed in the feed bunk area it is very well possible that the entire herd could have been feeling a voltage level of over .500 volts on a very regular basis.

ELECTRICAL PROBLEMS ON THE FARM

Some code and safety concern on the farm were found; however, none of these codes or safety violations were causing stray voltage.

MITIGATION

In 1980 the farmer built a milking parlor setup (on an equipotential plane as recommended to prevent stray voltage problems) for 125 cows milking three times a day. The farmer worked up to 86 cows and when things did not seem to be working, he cut back, hoping to again work toward the goal. By the time the farm was isolated the farmer was only milking 40 cows.

The farmer was isolated on June 11, 1993. In the summer of 1993 he expanded the grazing, but the cows with mastitis problems would not clear up. The farmer eliminated those cows. He also could not get corn planted and finally settled for planting sudan/sorghum/soybeans for in the silo. This grew to record heights but this past winter it did not produce milk or body energy like corn would have. So now the farmer was again experiencing reduced milk production due to lack of quality feed. In addition, he could not afford to buy the quality he should have.

On July 11, 1993, the farm was isolated. By the middle of July the farmer's symptoms were gone and they never returned. In December 1993 he quit taking allergy medication and has not had another sore to this date. He has also gained weight and now looks better than he has in years even though he is still under a lot of stress due to the financial situation. The farmer continues to go to Mayo Clinic for evaluations and there are no signs of any more problems with his eye.

Most of the farmer's cows and heifers calve during the half of the year. Nearly half of those calving between January 1 and July 1, 1993, either died or had to be sold due to mastitis, tumors, and other health problems. Several of their calves died or were born dead. In 1980 the farmer remodeled to milk 125 cows. On January 1, 1994, the farmer had 41 milk cows left with a number of them dry.

Of the animals calving between July 1 and December 31, 1993, (after the farm was isolated), only one gave birth to a dead calf. Not one calf died after birth. The calves could stand up, walk, drink milk, and eat, unlike many born before the farm was isolated. Not one cow or heifer died in that time period.

OBSERVATIONS AND CONCLUSIONS

In addition to personal problems of the farmer's wife (back injury and loss of full time job) the farmer has recently lost a calving cow and her calf. The past couple of growing seasons were not conducive crops for top milk production. In the past couple of years the farmer has had to deal with doctors, physical therapists, bill collectors, courts, and lawyers. The farmer has heifers that will finally calve at 32 to 36 months of age because they did not breed until early last summer. Now stray voltage is suspected as the cause of many of these problems.

The farmer is trying to rebuild his herd. This spring he will make the final move to intensive rotational grazing. With most of our calves born early in the year, seasonal milking is a definite possibility.

There are changes in the way the farmer's cattle act now. They stand around near the feed bunk and water tank. They drink water instead of lapping at it. The farmer no longer is kicked during milking. Cows milk out quickly and evenly without lopsided udders. Most of his cows and heifers will be calving within the next few months. Calves are now born healthy. There are some animals that do not (and probably will not) respond. The cows are not producing much milk and the Somatic Cell Count has been erratic. The farmer is hoping that will change with his next lactation.

Now the farmer has heifers calving that were never kept near the barn until they came in off pasture after he was isolated. #306 calved with twins in August and had an SCC of 71,000 in February -- the lowest in the herd. #305 came fresh this past week and has a nearly perfect udder. There is not much milk yet, but that should improve, especially after the farmer can get more and better feed. There are other heifers coming up also. They are small, but they look better than the cows.

CASE 107

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production, began at 17,500 and dropped to 13,200

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts, rose to over 1,000,000

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

Dogs arthritic

Dogs sore pads

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs
2nd person frequent headaches
1st and 3rd person frequent flu-like or cold symptoms
1st and 3rd person excessive fatigue
1st person often feeling under stress
3rd person weakness and pain in legs
1st and 3rd person forgetfulness
1st and 3rd person pressure behind the eyes
1st and 3rd person unexplained nausea
1st person unexplained general feeling of not being well
1st person occurrence of heart related ailments

GENERAL INFORMATION

FARM CHARACTERISTICS

The farmer operates a parlor type dairy farm. The farm is located on a hill with a ravine running through the farm with numerous springs on the side hills. During the time of measurements soil moisture was extremely high and periodic rain showers persisted through the day.

At the present time the farmer has 57 cows that are milked in an eight position, herringbone parlor. He purchased the farm from his father in about 1985 and has had a considerable experience in the dairy business. He has an experienced dairy person assisting in the milking and caring for the cattle. He built the parlor and a number of the buildings connected with the dairy operation.

A casual observation of the cows supported the farmer's belief that he had a good herd of dairy cows. At the present time there were very few health problems, only a few cows with sore legs and with bacterial infections. The behavior of the cows was also good. Only a few required some restraint in the milking process. There were 8 positions for cows in the milking parlor and approximately 2 hours were required to complete the milking of 57 cows using 8 machines. The cows, in general, appeared to be in very good condition. A few leg problems were observed and a few cows had difficulty walking. The farmer stated that he had 4 to 5 abortions each year. Breeding and heat detection were not as good as he would like but much improved from before isolation. He uses a bull for breeding but also some AI. He has used steroids and antiinflammatory drugs for cows because of appearance of pinched nerves. Cull rate is at 27%.

ELECTRICAL EFFECTS ON THE FARM

Unusually high rate of failure (non-lighting related)
Increasing motor burnouts
Noisy telephone requiring frequent service calls or having false rings

HISTORICAL BACKGROUND

In August of 1985, the farmer and his wife agreed to purchase his father's dairy farm. That same fall, they renovated the milking and livestock facilities in order to accommodate a larger herd. Since the farmer was in the dairy business previous to this year, he was somewhat aware of the problem of stray voltage.

The first part of 1986 was spent trying to acclimate the cows and personnel to the new facilities and management. On-going herd health, production, and labor requirement problems during the year prompted the farmer to contact the State Agricultural Engineering Department on September 15, 1986 to discuss the observed line voltage drop between the service entrance and the dairy barn. It was suggested

to the farmer that he contact the power company to request that their service be moved closer to the main use of power on the farm. The farmer contacted the power company on November 7, 1986 and requested this. An engineer from the office was sent out to the farm, and subsequently the request was refused. The problems of animal health, milking time required, and high somatic cell counts continued. In December 1986 the farmer contacted a county extension agent and requested a milking equipment check. This agent specialized in dairy and possesses the necessary equipment to check efficiency of milkers, vacuum pumps, and pulsation. When he arrived on January 22, 1987 he ran checks on the equipment. All equipment was operating within the acceptable range and seemed adequate. The engineer made a few suggestions regarding milking procedures, but could offer no definite solutions.

Furthermore, on January 17, 1987 the State University Extension Dairy Specialist was called to make a farm visit to discuss facilities, management, ration, and to give his opinion on the problems of the farmer. However, no obvious problems were discovered. Management, feeding, and facilities were determined adequate.

During 1987 and 1988 herd health problems grew more intense. Many animals were either lost or sold due to health problems. All this time, stray voltage was discounted due to the precautions the farmer had taken in 1985 when the parlor was remodeled.

In 1987 and 1988, due to the loss of livestock, several veterinarians were consulted. Their diagnosis was Johne's disease. Numerous samples were sent to two State University labs. All tests were returned with negative results. The best opinion offered was that tissue samples "appeared to be indicative of Johne's."

Foot rot, high somatic cell counts, mastitis, and reproduction problems all increased in intensity and the number of cows affected. In February of 1989, new milkers and a pipeline were purchased in a futile attempt to improve performance.

On August 17, 1989 the milking equipment supplier discovered the problem. Stray voltage measuring well over a full volt at any given time was observed. During the next two weeks, he attempted to isolate the problem with no success.

The power company engineering department was notified on September 12, 1989. They came out and observed the problem with their own equipment. The farmer was told the problem was probably somewhere on the farm and would have to hire an electrician to improve the grounds. On September 28, 1989 additional ground rods were installed to improve the neutral connections in the parlor. The farmer received a bill for this futile service totalling \$480.00. All during this period, Interstate personnel were periodically recording stray voltage levels on the farm. Stray voltage levels remained unchanged. Utility personnel refused to admit the possibility that the voltage was coming from their lines.

The utility then decided to move the main electrical service closer to the main location of power usage on the farm. The consulting engineer admitted at that time that he did not "hold much hope" that this would solve the problem. Interstate moved their transformer closer to the center of power usage. New poles were also installed by the power company. This required that the farmer install, at his expense, a new 400 amp. service, regrounding of other outbuildings, and installation of new overhead wiring. The cost to the farmer was an additional \$1,024.00. This accomplished nothing to solve the stray voltage problem.

During this period, the farmer repeatedly requested that the utility isolate or disconnect their neutral from his to at least eliminate that as the source of stray voltage. These requests were refused, with the explanation that Interstate policy did not allow them to do this. Frankly, the farmer was brushed aside as not being informed enough to have an educated opinion. It was also stated that this would be an illegal connection. But the farmer also had knowledge that neighboring R.E.C. power companies had a policy of immediate isolation when a stray voltage problem is even suspected.

After installation of the new service, it became apparent that the utility was ignoring any further involvement. No information recorded by their devices was supplied to the farmer despite several requests. It was obvious in the barn that the problem had not been solved. On December 18, 1989 the farmer called the power company and left a message. The call was not returned. On December 19, 1989 the farmer contacted the power company's Engineering Department and, being "at the end of the rope," was somewhat vocal in the demand that the neutral be isolated. The farmer did not stop with threatening legal action.

On or about December 27, 1990, the effects were evident. One hour per milking was saved. The cows began entering the parlor without hesitation and were much easier to handle.

On January 30, 1990 voltage recorded at the time of milking was .030, far below the .50 volt level said to be the threshold of tolerance by dairy cattle.

Since that time, as the farmer's DHIA records indicate, production, herd health, somatic cell, and the cows' appetites have all improved. The number of animals lost to the "suspected Johne's" disease was reduced to one in early 1990. As the farmer has been told by other dairymen and dairy consultants, these factors will continue to improve over time as the affected animals are gradually culled from the herd. Some will improve slowly, while others will have permanent damage.

One question which remains unanswered is the safety of the device that the power company has used to isolate the neutral. The farmer was told that the use of a lightning arrestor as an isolator is illegal and unsafe to the family and the livestock. This is currently being investigated.

All monetary amounts of losses were computed using statistics and formulas researched and furnished by the State University Extension Dairy Specialist. The farmer's official Dairy Herd Improvement Association records dating from November 1986 were researched on a month by month basis. All losses were tabulated from the state dairy herd averages, not Mid States DHIA top 25% averages. My rolling herd averages alone during that period would indicate an above-average herd.

The power company's reluctance to expedite the matter, supply information pertaining to levels recorded, and their overall indifference has compelled the farmer to seek compensation for substantial damages from the stray voltage.

MEASUREMENTS

The following measurements took place at the farm on the evening of July 12 and the day of July 13, 1993.

Measurements of 60 Hz magnetic fields were made around the home at approximately 10 PM. Measurements revealed that 60 Hz currents were present in water pipes and on the gas line coming into the home. These currents produced 60 Hz magnetic fields greater than 10 mg to be in some areas of the home. Steve uses a water bed which also produced a significant 60 Hz magnetic field if the heater is on. The rest of the house is quite average showing no high 60 Hz magnetic fields. Currents as high as few amperes were measured on the gas pipe. The association seemed to be with the grounding of the gas pipe to the furnace in the home and the furnace in the shop, each of which is connected to the neutral.

Voltages measured between different metal parts in the pit of the milking parlor were as high as 0.56 volts and that was from the steel dividers on one side of the parlor to the steel dividers on the other side of the parlor. There was also 4 - 8 ma of current in steel pipes in the parlor. The 60 Hz magnetic fields ranged between 0.1 and 0.2 mg in the pit with higher values near electrical equipment. Direct currents were measured in the water pipes and were in the range of 20 to 30 ma. The voltage levels on the primary and secondary neutrals indicated that the isolation device was separating the neutrals at the transformer pole.

Measurements in the milk room revealed the presence of 800 ma of 60 Hz current on two water lines above the sink. This current divided as the water pipes branched to various locations. After milking, each piece of electrical equipment was turned off in order, until the source of the current was discovered. The turning off of the compressor caused the current level in the pipes to drop to a few ma. The compressor is a 240 volt load which would indicate that either the current was coming from the primary side directly through the earth and therefore bypassing the isolator or a problem existed with the compressor. Steve was having the compressor checked. There was 2.7 ma on the milk line as it went into the bulk tank but not large enough to be measured in the parlor. Measurements on the ground wire from the electrical box in the barn to the ground rod outside indicated significant currents as well. With the entire farm turned off there was still 0.5 ma on the specific ground wire connected to the equipotential plane. Current is still in the grounding system even though no electricity is being used on the farm and no electricity can be put into the ground by the secondary system. As 240 volt loads were turned on in the barn, currents were increased on the secondary grounding wire by about the same amount as when an be from the primary side. equivalent 120 volt loads were turned on. 240 volt loads should not put any current on the secondary neutral whereas 120 volt loads have the same current on the neutral as on the high voltage wire. The fact that the difference was not significant would indicate that the majority of current in that ground circuit must be from the primary side.

At the transformer pole at 6:30 AM there was a current of 80 ma going into the earth on the primary side and 10 ma on the secondary side. There was also 450 ma on the propane gas line. That line connected to both the house and to the shop. Between the ground and the anchor a multimeter measured 2.9 volts on the primary and 0.19 volts on the secondary. DC was 0.26 volts on the secondary and 0.25 volts on the primary. A wire was used to connect the primary and secondary neutrals. There was 1.2 amps in this wire. When the primary and secondary were connected the voltage between the neutrals and the anchor was 0.57 volts. At 11:30 AM there was 2 amps on the gas line.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

After the isolation devise was installed the behavior as well as the health and production of the dairy herd dramatically improved as can be verified by farm records. The milking time decreased from approximately three to two hours at the time the farm was isolated. Production increased significantly and immediately after isolation. In addition the people working in the barn also noticed a significant improvement in their own health and well being. Isolation rarely solves a stray voltage problem but can significantly improve the profitability of the dairy operation.

He took into account the Universities' recommendations for equipotential plane in the milking parlor and surrounding area to prevent the shocking of the animals during milking. The additional grounding that was installed on the farm would have decreased the resistance in the farm grounding system. All electric conductors in the barn were connected together and interconnected to the equipotential plane and the farm grounding system. Milk production was at 12,000 pounds rolling herd average in 1986. With the addition of a brother-in-law's cows production went to 16,000 pounds. In a dry year the peak production was 16,000 pounds and the production dropped to 13,500 at its lowest point.

SPECIFIC CHANGES IN NUTRAL GROUNDING

In addition ground rods were intalled to improve the neutral connections in the parlor. There was no change in herd behavior, health or production.

MITIGATION

Because the farmer experienced numerous health and production problems with his dairy cows and his own health the Electrical Utility serving his farm installed an isolator in December 1989 which was identified as a lightning arrestor. The farmer installed a grounding grid in the cement floor on which the cows stand while being milked. The grid was welded to copper wire and connected to two ground rods on

each side of the parlor. The entire system was then connected to the stainless steel line which carries the milk to the milk pump and then to the bulk storage tank. All electrical equipment (motors, switches, etc.) had a direct feed through the stainless steel line. The electric current flows through it to the neutral side of the main electrical panel in the parlor and from there back to the power source. New grounding has been added on the farm as the result of recommendations of the Electric Utility.

OBSERVATIONS AND CONCLUSIONS

No mitigation procedure has solved the problems on this farm. Isolation had the greatest positive impact.

CASE 108

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Breedback difficulties
Cow production peaking early and not holding
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair
Newborns seemingly lacking instinctive intelligence

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters

HUMAN HEALTH

1st, and 2nd person tingling or numbness in arms or legs
2nd person frequent flu-like or cold symptoms

2nd person vision problems (e.g., blurred or heavy eyelids)
1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st and 2nd person forgetfulness
1st and 2nd person ears ringing
2nd person pressure behind the eyes

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm is located at the edge of a small river between two electric utilities systems. The entire farm has been rewired using a four wire system in which the secondary neutral is grounded only at the transformer pole. The transformer pole is in the center of the yard with the primary and secondary grounds in the same general area. The well is over 100 feet deep and is about 25 feet north of the transformer pole. The stall areas and the nearest region of the feeding area have an equipotential plane installed according to the utilities specifications. The dairy barn has been remodeled and has new modern equipment. This farm also has the latest in farm equipment as well.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusually high rate of battery failures
Radio and TV failures not related to lightening storms.
Occasional shocks from water lines and faucets
Accelerated corrosion of well casings or other buried pipes
Unexplained fluctuations in electric bills.

HISTORICAL BACKGROUND

This farm family has lived on this particular farm for 2 years but has observed stray voltage symptoms for 3 years.

MEASUREMENTS

Maximum primary neutral to earth voltage: 2.244 AC EGS survey
Minimum primary neutral to earth voltage: .069 AC EGS survey
Maximum secondary neutral to earth voltage: 2.253 AC EGS
Minimum secondary neutral to earth voltage: .069 AC EGS
Cow contact points - .4 DC between gutter wall and water line

.7 - 1.5 AC between heifer shed and water fountain

Most interesting was the presence of 0.010 VDC between the stall dividers on the North and South sides of the barn. The short circuit current between the same two points was 2.0 mADC which was not a constant. The conductivity in the floor of the barn between the two sections of equipotential planes was quite high. The floor of the barn or the earth itself is highly conducting and therefore one would expect to see the currents which are traveling to substations to find this area a less resistive path. When observing the voltage between the two sides of the stall dividers, DC, 60 Hz AC and approximately 2 mHz RF were noted to be present. The 60 Hz and the RF were a few mV.

At the transformer pole the measurements revealed the presence of 60 and 120 Hz as well as, at times, a higher frequency (perhaps 600 to 1000 Hz). The 120 Hz is of special interest because it is quite unusual in the 60 Hz system. Odd harmonics commonly occur in the system and in the ground. DC was also present and the interesting aspect of the DC measurements was that the short circuit current would rise and fall over a time period of minutes. There was also an oscillation with a period of approximately 1 s. The 120 Hz was dominant when measuring between the well casing and an independent ground rod near the transformer pole. It represented perhaps 90 % of the measured AC voltage. The RF was highest when connected to the grounds on the lightning rods.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Changes in electrical wiring: completed 4 wire system, provided switches for breaking neutral connections to barn cleaner and silo unloaders when not in use. Changes in electric utility system: a neutral isolator was installed within the past year, with every pole between this farm and town now having ground connection on the neutral line. No improving effects.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

Primary neutral: grounded further away from transformer pole when isolator was installed.
Secondary neutral: grounded further away from barn.
Electrical equipment: ground wires were installed to the fan motors and on bulk tank compressor.
No improvement in conditions on farm.

MITIGATION

For the first 60 days after installation of equipotential plane everything went well. About 60 days later there was a noticeable difference in the milking: poor let down, slow and uneven milkout, mastitis problems, increase in cell count, and also noticed that the cows did not lie down in the barn but would lie down in snow immediately after going outside. Lapping at drink cups and kicking at milker unit also became a problem. The installation of the equipotential plane created conditions in the barn such that the cows would not lie on the floor. When they were turned out of the barn they would virtually drop to the ground apparently because of fatigue. When the equipotential plane was isolated from all grounded and grounding systems, conditions improved in the barn so that, at least, the cows would lie down. The cows are no longer allowed outside for fear of the cows hurting themselves as they leap over the gutter or not being able to get cows in their stalls. After an isolator was installed, conditions improved for a short while and problems returned.

OBSERVATIONS AND CONCLUSIONS

There is a serious behavioral, health and production problem for the cows on this farm.

The problems, symptoms and effects are characteristic of stray voltage farms.

Measurements in the barn indicated that very little AC is present as cow contact voltages even during electrical use on the farm. The fact that 240 loads produce AC voltages between contact points in the barn, however, indicates that the earth is a carrier of electricity.

The fact that a ground fault on dairy farms puts electricity in the earth and accepted in the dairy industry to cause the set of effects experienced on this farm, the only conclusion that can be drawn, is that the electricity going into the ground from the electric utility system is the primary cause of the problems for the dairy cows.

The closeness to the large sources of electricity and the electrical conditions on the farm should call into question the use of this farm as a dairy farm unless the electricity in cows are affected as they are on this farm, it probably is not a the earth is eliminated and the transmission lines moved. When healthy place for people to live either.

CASE 109

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

Dogs won't enter barn

Dogs dig holes in ground
Dogs get very thin with dull coats

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs
1st, and 2nd person frequent headaches
1st and 2nd person frequent flu-like or cold symptoms
1st, 2nd, and 3rd person vision problems (e.g. blurred or heavy eyelids)
1st and 2nd person problems with breathing
1st, 2nd, and 3rd person excessive fatigue
1st, 2nd, and 3rd person frequent irritability
1st and 2nd person often feeling under stress
1st, 2nd, and 3rd person weakness and pain in legs
1st and 2nd person forgetfulness
1st, 2nd, and 3rd person ears ringing
1st and 2nd person pressure behind the eyes
1st, 2nd, and 3rd person unexplained general feeling of not being well
1st and 2nd person rheumatoid arthritis
1st person (female) feeling bloated/retaining body fluids
1st person (female) problems with menstrual cycle
1st and 2nd person occurrence of heart related ailments
Unable to get restful sleep at night
Sore lumps under armpits

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm is located away from any development in an area of mainly dairy and grain farms. A high water table exists on the farm with wetlands and water bodies near by. The transformer is on a pole in the middle of the farm yard within 20 to 40 m of the buildings. A 65 KV line on the farm property was removed and a double 65 and 161 KV line built. This line is forty meters from the farm home and has been associated with a significant increase in the problems on the farm. At the same time the new line was built a new large substation was built about 1/4 mile SW of the farm. In addition a buried open neutral REA line is to the west across the road.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusual failure rate for incandescent bulbs
Unusually high rate of battery failures
Radio and TV failures not related to lightening storms
Increasing motor burnouts
Accelerated corrosion of well casings or other buried pipe

HISTORICAL BACKGROUND

For many years this farm family has had problems in their dairy operation which cannot be controlled by good management procedures.

MEASUREMENTS

In all the measurements that were made 60 Hz currents were found in everything. Nothing was free of currents. In places AC voltages over one volt were measured as for example between the copper gas line and the reinforcing steel in the basement walls. Measurements in the barn turned up relatively small voltages--less than 0.5 volts in any contact area. There did seem to be some "static" buildup on some conducting parts which appeared to be associated with lights being on or fans being connected but not on. The currents capable of being generated by these changes were small --less than a milliamp. The currents between the equipotential plane and the neutral were in the range of from 40 to 68 ma, however. DC between the equipotential plane and the neutral/ground system ranged between 8 and 8.5 ma. Throughout the farm the highest AC voltage found on any neutral was 0.5 volts. Currents, however, were quite high on grounding wires ranging up to 100 ma AC. The currents were especially high at the utilities poles on the South side of the farm. Grounding wires were extra heavy, on every pole and each went to groups of 10 ft ground rods. 60 Hz magnetic fields ranged from 6.2 milligauss under the line to 1.5 mg in the home and 0.5 mg in the barn. AC electric fields at 1.5 meters above the ground and under the lines was 850 v/m. These measurements were made, however, when only one of the lines was operating. In the measurements with the oscilloscope, it was clear that the electricity in the earth had some distortion such as squaring the tops and bottoms of the wave forms. In addition the oscilloscope also revealed the presence of electromagnetic energies in the range of 1 MHz. Of special interest was the observation of a correlation between the variable pattern of the sound associated with the distribution poles south of the home and the wave form shown on the oscilloscope. The oscilloscope was connected between the neutral and a reference ground. The same association was present for the oscilloscope connected between two grounds independent of the neutrals.

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

When a 65 KV line was removed and a double 65 and 161 KV lines were added conditions became unbearable. As a result, this farm family no longer sleeps in the home at night and their cattle had to be moved to a farm 5 miles east of theirs. During the time of the measurements the 161 KV line was not operating. The farm family perceived that conditions were much better than a normal Saturday afternoon.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

A discovery was made which revealed that increasing grounding to the north of the barn could considerably improve conditions. The decision to ground their electrical system to the North was prompted by measurements which the utilities had made. During the utilities measurements the farm family observed a difference in the cows' behavior when the ground connection was made to a ground rod North of the barn. With that grounding in place, conditions were better.

MITIGATION

An equipotential plane was installed in the barn. The equipotential plane improved the health and behavior of the cows for only about a week after which the conditions became even worse.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

Because of the deterioration of the dairy cows, the cows were moved to another farm, some distance away from the line. The cattle have recovered and act like a normal healthy herd. Before being moved they could neither eat nor drink and were nearly uncontrollable while in the barn. Milking each cow required 15 to 30 minutes if the milker could be kept on. The members of the farm family were also experiencing problems which correlated with the time spent in the home and on the farm. They have, therefore, chosen to not sleep in their home.

Both in the barn and in the basement of the home the concrete floors are cracked beyond anything that would be normal. Hairline cracks are also throughout the concrete blocks of the barn wall.

CONCLUSIONS

There is a serious behavioral, health and production problem for the cows when they were on this farm.

The problems, symptoms and effects are characteristic of stray voltage farms.

The utility company has verified that current goes directly through the earth to the barn from the neutral on the buried line. Measurements of AC magnetic field over the buried line revealed an imbalance between the neutral and high voltage currents. Consequently the neutral current which is free to enter the earth at all points along the line is and therefore can follow an earth path back to the substation which may be the farm which would normally be expected to have a high conductivity.

The effects on humans and animals observed and recorded by the family and others and the results of measurements all point to the transmission line as the major source. Obviously all of the other sources of electromagnetic energy can contribute to the conditions on the farm.

Resonance of the utilities poles to the South of the farm is not normal and requires further investigation. Wires on these poles from the neutral were all grounded with extra ground rods and were extra heavy. The poles produced a sound with a frequency in the range of 100 Hz. The intensity would increase and decrease in a manner completely independent from electrical use on the farm. The sound was like that of an electric motor that was running nonuniformly. Also in observing the 60 Hz wave form, there was a movement in the pattern characteristic of the changing triggering time which corresponded to the wobble in the sound from the pole. There could be a current in the pole such as to drive the pole to oscillate in a particular mode under resonant conditions. A first analysis seemed to support the cause to be connected with the electrical energy in the earth. Another possibility is the vibration of the electrical line providing the energy for the resonance vibrations. Of significance also is that it is only the poles near the farm that appear to produce the resonance sound. There could be a connection between this resonance and the cracking concrete. It is possible that the electrical current in the earth could provide the energy for a resonant condition in the concrete which would increase the internal stress and possibly enhance cracking. Both of these unusual conditions require further investigation.

CASE 110

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout
Poor milk production, began at 17,500 and dropped to 13,200
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts, rose to over 1,000,000
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die

HUMAN HEALTH

1st person tingling or numbness in arms or legs
2nd, 4th, and 5th person frequent headaches
1st, 2nd, and 4th person frequent flu-like or cold symptoms
1st, 2nd, and 5th person vision problems (e.g., blurred or heavy eyelids)
1st, 3rd, and 4th person problems with breathing

1st, 2nd, 3rd, 4th, and 5th person excessive fatigue
1st, 2nd, 3rd, 4th, and 5th person frequent irritability
1st, 2nd, 3rd, 4th, and 5th person often feeling under stress
1st, 2nd, and 5th person weakness and pain in legs
2nd and 3rd person forgetfulness
4th person pressure behind the eyes
3rd and 5th person unexplained general feeling of not being well
3rd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
5th person (female) problems with menstrual cycle
3rd and 5th person having an illness that medical professionals cannot diagnose
1st person charlie horses
4th person dizziness

GENERAL INFORMATION

FARM CHARACTERISTICS

This farm family owns and operates a dairy farm with a dairy herd of about 40 Holstein cows. The cows are housed in a free - stall barn and the cows are milked in a twelve stall area. The farm is located in a region where significant quantities of ground water are near the surface. A high water table exists throughout the area. To the South of the farm approximately 600 to 700 feet is a three phase distribution line and the farm is feed by a line coming in about 100 feet to west of the home. The transformer is located directly to the west of the home. The ground rods for the primary and secondary neutral are separated by about 15 feet and on the west side of the home. The entrance ground and the telephone ground are separated by about twelve feet and within two feet of the foundation. The electricity for the barn is fed from the entrance box in the home which would electrically couple the home to the barn. The home was built on a concrete slab perhaps because of the high water table.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Radio and TV set failure (non-lightning related)
Increasing motor burnouts
Occasional shocks from water lines or faucets

HISTORICAL BACKGROUND

The symptoms have been observed for 60 months. The human and animal symptoms occur within the same time frame. One family member has been ill since 1982. She has had endometriois (uterus attached to bowels) for 3 1/2 years. She also passed a gall stone 3 years ago. Recently, she had an EEG that was not normal. She has also experienced dizzy spells, seizures (which are not always alike), lumps in breast, and a general feeling of not being well. Another family member has also had several unexplained ailments. She has had 3 EEG's that were not normal, an unexplained blackout, and a spontaneous abortion 4 years ago. Yet another family members stomach problems became so bad that her diarrhea prevented her from riding the school bus to school for a week. All of the tests they ran on her were OK. She also has dizzy spells and tried to commit suicide.

MEASUREMENTS

The AC potential between the primary neutral and secondary neutral grounds ranged from 3 to 4 volts, continuously changing, and the DC potential was oscillating. There was an AC magnetic field of 6-7 mg with the coil in contact with the primary neutral ground wire indicating a current of approximately

250 mA in the earth from the primary neutral. There was no additional AC magnetic field from the secondary neutral ground indicating no current on the secondary neutral grounding wire.

Between the secondary neutral and the telephone ground was an AC potential of 2 volts and again an oscillating DC potential. The value of AC was also continuously changing.

There was an ambient AC magnetic field of from 0.4 to 0.6 mg throughout the area around the home. The field increased as one went in the direction of the three phase distribution line. In addition the AC magnetic fields within the home were about the same as outside. These magnetic fields appeared to be caused by a combination of currents in the earth and on the three phase distribution line.

As mentioned, the AC magnetic fields inside the home ranged from 0.4 to 0.6 mg but increased from 30 to 50% at the time of evening milking. The waveform of the AC magnetic field, as observed on the oscilloscope, was complex revealing the presence of a number of harmonics and was continuously changing. The oscilloscope also indicated a strong connection between people and the floor. That is the electrical state of the people seemed to be associated the floor and the electricity in the floor.

AC potentials measured in the barn were less than 0.3 volts which were too low to shock the cows but did indicate a high conductivity in the earth which could increase the probability that the cows could still be affected even though not shocked. One time, for a few minutes, AC potential in the barn between secondary neutral and gas line was 2 volts. These results could not be reproduced.

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

SPECIFIC CHANGES IN NEUTRAL GROUNDING

These changes included the separation of the primary and secondary neutrals as well as the telephone ground disconnected from the utility ground. Both changes seemed to have a positive impact on both the people and the cows. Even after these corrections, conditions do not seem to be quite right.

MITIGATION

There has been an isolation device installed. Measuring only slight effects on AC voltages in cow contact areas as a result of isolation. In some places there was an increase and in other places a decrease in AC voltages. In all cases the voltages were under 0.5 VAC except for spikes.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

During the last several years this farm family has experienced health and production problems in their dairy herds as well as health problems among members of the family. Experts have investigated electrical conditions on the farm and provided recommendations for changes especially in the grounding of their electrical system. One engineer found that the majority of the voltages on this farm are of an induced, low current - producing capability type or source. An electrical engineer discovered the telephone ground connection to have a significant impact on the human and animal conditions. The electric utility serving the farm recognized the existence of the stray voltage problem by the amount of financial assistance provided.

CONCLUSIONS

The proximity of the three phase distribution line and grounds; the location of the primary and secondary grounds west of the home and along the foundation of the home; the presence of a current only in the primary and not in the secondary ground wire, would suggest that at this time the current in the primary ground could at least partially be reaching the home directly through the earth and getting on the grounds next to the foundation and the concrete floor. Changes in electrical use in the barn or in the area could, therefore, affect the electricity reaching the home. At the present time with the separation of the primary and secondary neutrals and with the ground for the telephone line disconnected from the secondary ground, electricity may not be as likely to reach the barn through the earth as the home.

The location of the electrical entrance box for the farm and the earth conditions it is likely that the electricity in the home to which people can be exposed could vary with use on and off the farm. The fact that family members feel physically worse at the time of evening milking could be the result of these increasing electrical fields brought about by the normal increase in electrical use at that time of day. The direct earth connection seems to be a key issue.

Data and information connect the problems on this farm to electromagnetic energies. Changes in the farm operation, the electrical grounding on the farm, isolation and electrical load variations have been associated with the problems. The high water table, the ambient AC magnetic field and the level of electrical exposure for humans and animals are characteristics similar to other places where the same problems are present. The proof of cause and effect to these electromagnetic exposures is still not available which does not permit one to know beyond any doubt that the cause of the health problems is electricity.

A 345 KV AC transmission line is being proposed to be built 2000 feet north of the farm. If this line is built and used, both the cattle and people on this farm will be significantly impacted. The possibility for electrical current going directly through the earth between the transmission line, the grounding on the farm and three phase distribution line increases the risk for electrical exposure on the farm.

CASE 111
ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY
DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

- 1st person tingling or numbness in arms or legs
- 1st person frequent flu-like or cold symptoms
- 1st person vision problems (e.g. blurred or heavy eyelids)
- 1st person problems with breathing
- 1st person excessive fatigue
- 1st and 2nd person frequent irritability
- 1st and 2nd person often feeling under stress
- 1st and 2nd person weakness and pain in legs
- 1st and 2nd person forgetfulness
- 1st person ears ringing
- 1st person pressure behind the eyes
- 1st person unexplained nausea
- 1st person unexplained general feeling of not being well
- 1st person rheumatoid arthritis
- 2nd person (female) feeling bloated/retaining body fluids
- 2nd person (female) problems with menstrual cycle

GENERAL INFORMATION

FARM CHARACTERISTICS

ELECTRICAL EFFECTS ON THE FARM

- Unusually high rate of battery failure
- Noisy telephone requiring frequent service calls or having false rings
- Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

For many years this farm family has experienced problems on his farm which have been associated with stray voltage. In September, 1980 an isolation transformer was installed on the farm. Until 1984 an 115 KVAC transmission line crossed his farm within approximately 100 meters from his dairy barn. In the summer of 1984 the line was moved farther away from the farm buildings. The farm family has experienced unusual and extensive behavioral, health and production effects in their dairy herd. Hogs and poultry also suffered similar effects. Health problems for those living and working on the farm were also noted and questioned. Adding the isolation transformer in 1980 had not solved the problems. Because of the proximity of the transmission line to the farm, this farm family was convinced that electricity from that line was responsible. The family worked through the legal system to have the transmission line moved away from their farm buildings. During the summer of 1984 the transmission line was moved approximately 400 meters from the farm buildings. The family noted a significant improvement in the behavior, health and production of their livestock as well as in their own health. Since this stray voltage problem is not only associated with proximity to transmission lines, the effects were not totally rectified. In addition a number of residential developments were added, increasing the electrical use in the area. The additions usually required changes in the distribution system. As these changes were made the farmer also recorded changes in the behavior, health and production of his livestock. As an additional measure to control electricity from entering the ground on the farm, a special 120 V transformer and non-neutral to earth system was installed on the farm. Again there was a noted improvement in the health and production of the livestock and health of the individuals on the farm. In order to maintain the health and production of his dairy herd, this farmer financed a change in the distribution system so as to prevent the electricity from crossing his farm through the earth. Records of

farm production and health verify improvements correlating with the change. As is the case with many dairy farmers experiencing the same problems, these changes produce only temporary help. Electrical distribution systems use the earth to carry current. As a consequence most often there is sufficient current in the earth to fill in that which is taken out by a small change in one part of the distribution system. The magnitudes of the currents in the earth will vary according to the conductivity of the earth materials and the amounts put into the earth. As a consequence, the changes that have been made on this farm do not guarantee that electricity in the earth is not reaching the farm buildings.

In an attempt to better understand the origin of the problems, the farmer developed a method of electrically isolating a few cows from the earth. The method consisted of using a semitrailer and electrically isolated it from the ground with styrofoam. Three cows for which he had records of health and production for the previous year were housed in the trailer and were brought down only for milking. His records show approximately a 50 percent increase in milk production, decreases in incidents of mastitis and a decrease in SCC for cows housed on the trailer. The demonstration was repeated a number of times with a different set of three cows. Each time similar results were documented. Blood tests for animals on the trailer and animals housed on the ground revealed lower globulin levels for the cows on the trailer. The significant difference between cows housed on the ground compared with those housed in the trailer, all originally demonstrating the typical stray voltage effects, would indicate according to the globulin levels that being in the trailer reduced the level of immune stimulation. The same experiment was also tried for calves. On the farm the loss rate for calves had been about 30%. When housing the calves on the trailer, all of the calves survived and their growth increased significantly.

MEASUREMENTS

These farmers use the parlor system from milking their cows. When not being milked the cows spend their time in a yard area and shed. All modern equipment is used in the operation and everything is well maintained.

Many measurements have been made on this farm during the past 15 years. Most of the earlier measurements were based on the assumption that the cows need to receive a shock (a perceived response) before any health or production effects are considered possible. The assumption was made that if the cows did not experience a contact voltage between two points on the body which was greater than 0.5 VAC, no effects were possible. Because of the isolation transformer and the non-neutral to earth electrical system on the farm, cow contact voltages were most often below the 0.5 VAC. Because steel plates have been used on the floor of the parlor, there is little chance for cows experiencing an AC voltage of even 0.1 volt. There are, however, both direct currents and alternating currents in the earth on the farm. For example, measurements were made in the barn by another organization. These measurements indicated small AC voltages between a reference ground and the farm ground. With the electricity turned off on the farm there was an AC magnetic field of approximately 0.1 mg. Especially important were the significant and sudden changes in the direct current (DC) voltages measured in the barn.

Other measurements which have been made through the years on this farm have always revealed the presence of the AC and DC currents in the earth. The DC has been especially important since, with the exception of electrical storms, only very small direct currents are present in the earth. Under certain conditions chemical cells are also established in the earth which can produce DC. These natural systems are fairly constant and, therefore, cannot account for the sudden changes or the pulsing of the DC as measured on this farm.

Additional measurements were made on November 19, 1993. At this time the farm family was no longer milking cows. Similar to the other organizations results, the AC magnetic fields were approximately 0.1 mg in most places in the farm yard. A battery powered oscilloscope was used to observe the shape of the signal from the pickup coil of the milligauss meter. The magnetic field picked up

by the coil is produced by a electric current. The current producing the signal had a complex frequency structure. The trace had a triangular shape indicating a significant odd harmonic contribution. No change occurred with the electricity turned off. Measurements with a Fluke 87 also indicated the presence of current in the ground. These measurements were between a wire buried in the earth on the farm and the farm grounding system. Because of non-neutral to earth system, neither of these were connected to any electrical system. At the time of measurements, there was 0.030 volts and 1.0 ma with the farm load on and 0.024 volts and 0.8 ma with the farm electricity disconnected. The major portion of the electricity was 60 Hz. An additional 5 hp, 240VAC load was turned on resulting in no change in the voltage and current readings between these to grounds. This information would imply that about 80% of the current measured between these two systems originated from sources away from the farm.

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

SPECIFIC CHANGES IN NEUTRAL GROUNDING

MITIGATION

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

Symptoms observed for several years

Human and animal symptoms occur within the same time period

CONCLUSIONS

This farm is typical. In addition to all the management changes, every possible improvement in the on-farm electrical system has been made to reduce both the cow contact voltages and the current capable of reaching the earth from the farm electrical system. The same effects, although always changing somewhat every time an electrical change is made, are still present. If this farm family had not continued to attempt to control the electrical exposure of the cows, they would likely have been out of business years ago. Whether there is a cause and effect between these effects and EM's only more research can prove. The many examples of correlations between health and production effects for livestock and health effect for humans indicates that a connection exists. At the present time the associations and correlations between added electrical use in a region and the level of effects on the dairy farms is growing rapidly. With the present distribution system, added electrical use means additional currents in the earth. This farmer has documented these connections on his farm. Unfortunately for this farm family, new homes in his area are being added every year with no consideration for the increase in currents in the earth.

HISTORY OF EVENTS ON THE KENNING FARM 1980-1995

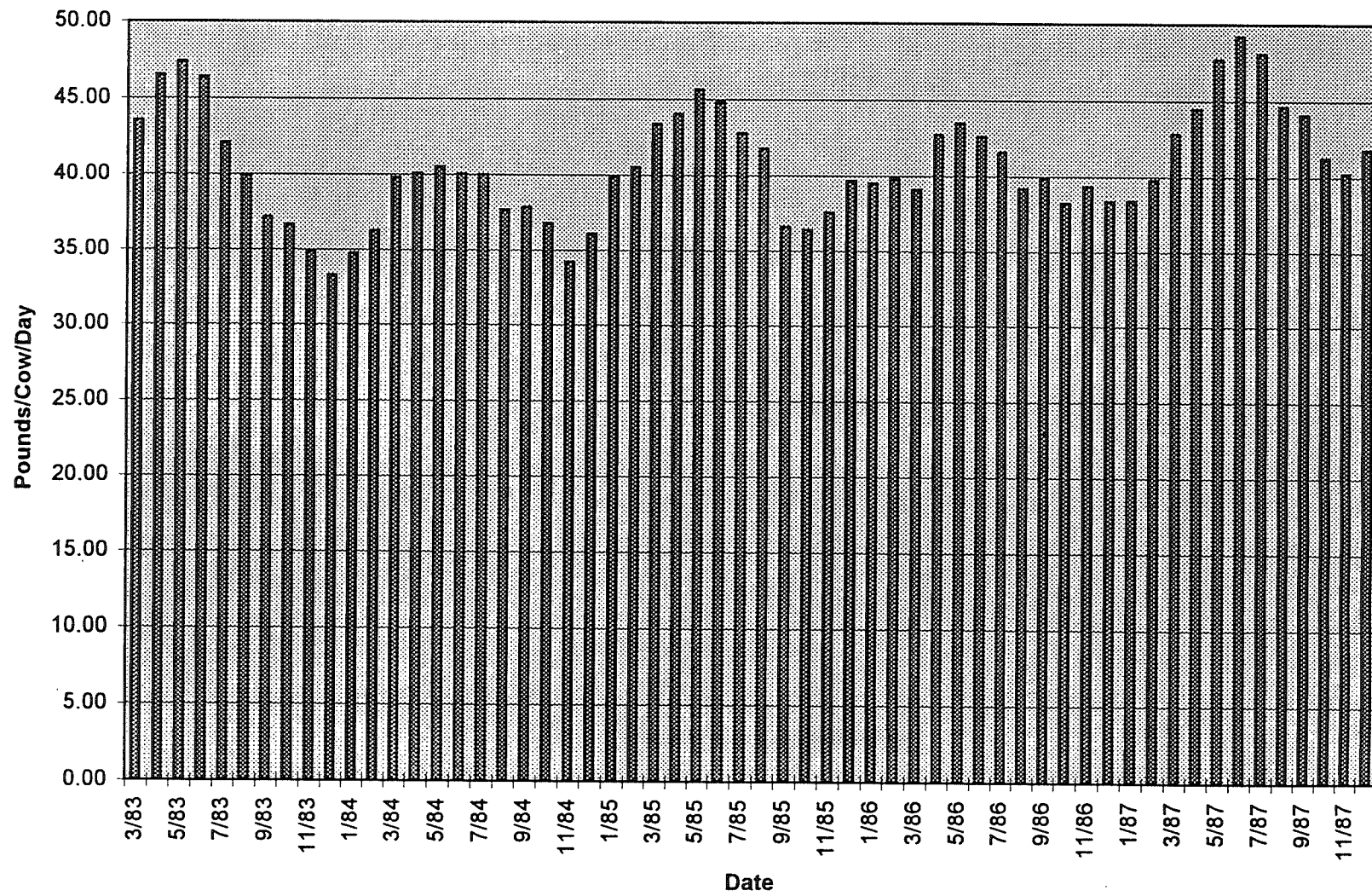
9/4/80	Isolation transformer installed.
7/22/83	Installed total steel plates on floor in parlor.
5/84-- 8/84	Transmission line running through farm is moved just off the farm.
7/85	Installation of 110V transformer and non-neutral to earth system.
6/86	Paid utility to put tie line in to take load off line past farm.
8/86-- 9/86	Utility changed line to neighboring town.
3/87	Utility disconnects neutral from tie line.
11/87	Bad vacuum tank.
8/27/93	SCC reaches over 1 1/2 million. Sold cows and quit milking.
6/94	Started milking operation again. Milk production only at 39 pounds per cow.
8/94	Disconnection of four grounds down below the hill the farm sits on.
10/94	Irrigator stakes grounded, neutral to pivot system.
12/23/94	Grounded well. 10 cows fresh in 80 pounds of milk. 1 cow fresh at 102 pounds of milk.
1/25/95	Ground wire across field, irrigator to pump.
1/29/95	Milk production reaches highest average ever at 54 pounds per cow.
1/31/95	Utilities connect two grounds on poles.
2/2/95	Utilities connect all primary neutral grounds.
2/3/95	Cows restless, kicking a lot during evening milking. Disconnection of two grounds.
2/4/95	Cows much better, seem relieved during morning milking.

Date	Pounds/Cow	Rolling Herd Average	Mastitis Treatments	SCC
1/83				0.00
2/83				0.00
3/83	43.56	13,285.80		0.00
4/83	46.53	14,191.65	12.00	0.00
5/83	47.38	14,450.90	23.00	0.00
6/83	46.40	14,152.00	9.00	1,250,000
7/83	42.10	12,840.50	9.00	0
8/83	39.97	12,190.85	13.00	1,500,000
9/83	37.19	11,342.95	31.00	1,250,000
10/83	36.68	11,187.40	31.00	0
11/83	34.88	10,638.40	9.00	0
12/83	33.31	10,159.55	15.00	0
1/84	34.75	10,598.75	13.00	980,000
2/84	36.30	11,071.50	23.00	0
3/84	39.78	12,132.90	3.00	980,000
4/84	40.09	12,227.45	9.00	1,050,000
5/84	40.55	12,367.75	7.00	720,000
6/84	40.05	12,215.25	16.00	845,500
7/84	40.00	12,200.00	14.00	858,000
8/84	37.69	11,495.45	8.00	910,500
9/84	37.85	11,544.25	2.00	809,500
10/84	36.80	11,224.00	6.00	801,333
11/84	34.22	10,437.10	0.00	777,167
12/84	36.13	11,019.65	0.00	438,333
1/85	39.88	12,163.40	0.00	432,500
2/85	40.55	12,367.75	1.00	343,500
3/85	43.39	13,233.95	3.00	379,500
4/85	44.05	13,435.25	4.00	385,500
5/85	45.65	13,923.25	4.00	384,000
6/85	44.84	13,676.20	3.00	389,333
7/85	42.83	13,063.15	3.00	531,750
8/85	41.79	12,745.95	0.00	588,800
9/85	36.61	11,166.05	0.00	947,000
10/85	36.43	11,111.15	0.00	647,000
11/85	37.58	11,461.90	0.00	421,000
12/85	39.70	12,108.50	2.00	521,000
1/86	39.51	12,050.55	9.00	613,500
2/86	39.82	12,145.10	0.00	730,875
3/86	39.13	11,934.65	1.00	771,750
4/86	42.75	13,038.75	1.00	894,000
5/86	43.52	13,273.60	1.00	772,666
6/86	42.66	13,011.30	9.00	812,111
7/86	41.62	12,695.02	8.00	837,273
8/86	39.18	11,949.90	2.00	781,818
9/86	39.87	12,160.35	1.00	620,000
10/86	38.26	11,669.30	0.00	466,250
11/86	39.35	12,001.75	4.00	350,000
12/86	38.35	11,696.75	10.00	616,667
1/87	38.39	11,708.95	2.00	

2/87	39.81	12,142.05	1.00	
3/87	42.86	13,072.30	1.00	
4/87	44.46	13,560.30	0.00	
5/87	47.72	14,554.60	0.00	
6/87	49.21	15,009.05	1.00	
7/87	48.08	14,664.40	10.00	
8/87	44.66	13,621.30	1.00	
9/87	44.12	13,456.60	0.00	
10/87	41.28	12,590.40	0.00	
11/87	40.24	12,273.20	1.00	
12/87	41.81	12,752.05	0.00	
1/88			8.00	
2/88			2.00	
3/88			5.00	
4/88			0.00	
5/88			0.00	
6/88			6.00	
7/88			17.00	
8/88			0.00	
9/88			10.00	
10/88			13.00	
11/88			6.00	
12/88			3.00	
1/89			3.00	
2/89			0.00	
3/89			6.00	
4/89			9.00	
5/89			6.00	
6/89			5.00	
7/89			6.00	
8/89			1.00	
9/89			1.00	
10/89			13.00	
11/89			11.00	
12/89			9.00	
1/90			24.00	602
2/90			4.00	524
3/90			4.00	569
4/90			8.00	482
5/90			9.00	493
6/90			39.00	802
7/90			56.00	1,049
8/90			32.00	889
9/90			26.00	731
10/90			30.00	544
11/90			15.00	523.00
12/90			18.00	610.00
1/91	41.81	12,752.05	9.00	629.00
2/91	41.20	12,566.00	14.00	613.00
3/91	42.56	12,980.80	20.00	719.00
4/91	44.84	13,676.20	24.00	631.00

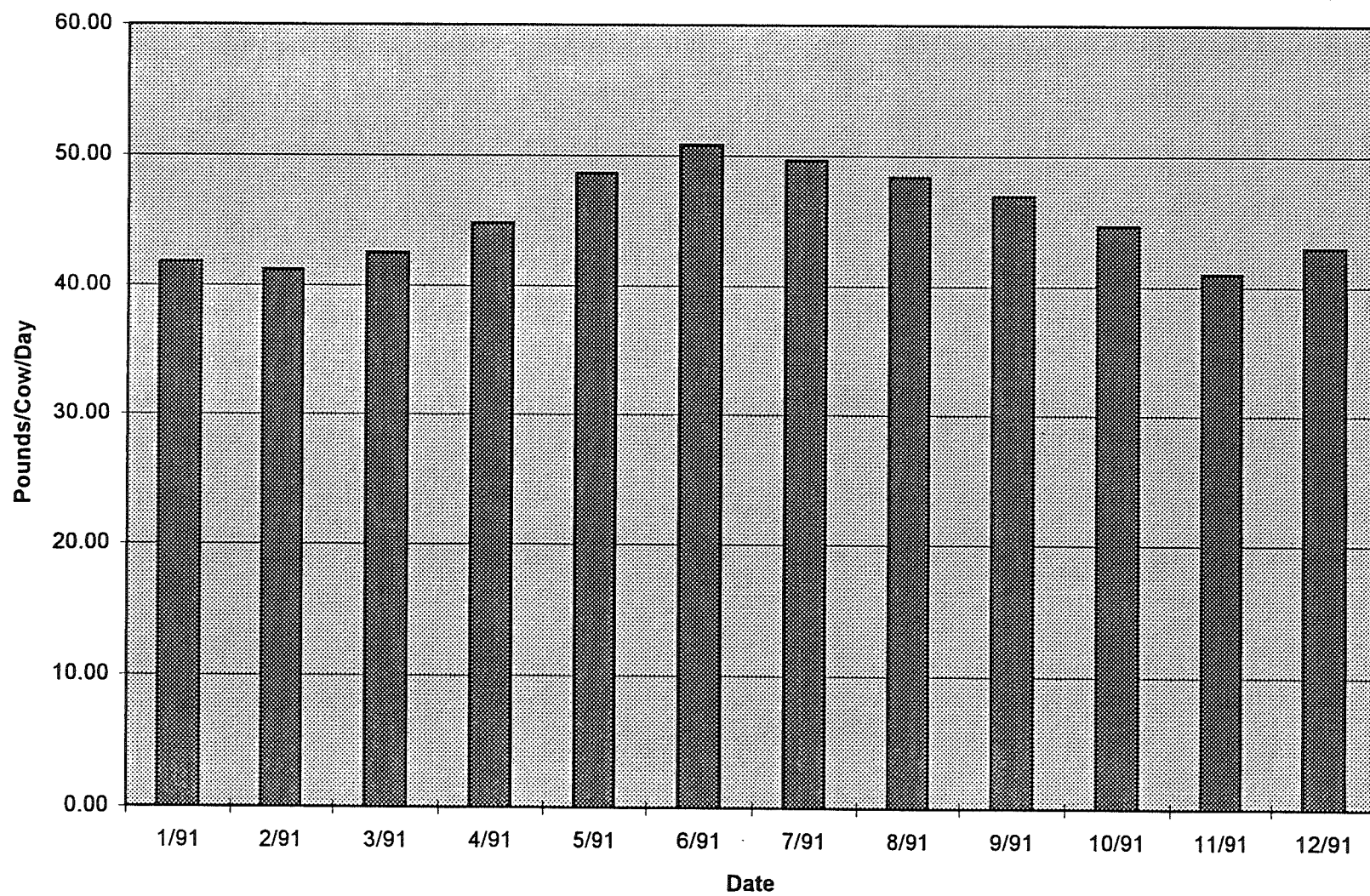
5/91	48.65	14,838.25	17.00	672.00
6/91	50.82	15,500.10	0.00	879.00
7/91	49.67	15,149.35	0.00	799.00
8/91	48.40	14,762.00	0.00	664.00
9/91	46.92	14,310.60	0.00	555.00
10/91	44.68	13,627.40	0.00	431.00
11/91	40.99	12,501.95	0.00	442.00
12/91	42.99	13,111.95	0.00	429.00
1/92				450.00
2/92				417.00
3/92				490.00
4/92				526.00
5/92				525.00
6/92				476.00

Milk Production on the Kenning Farm

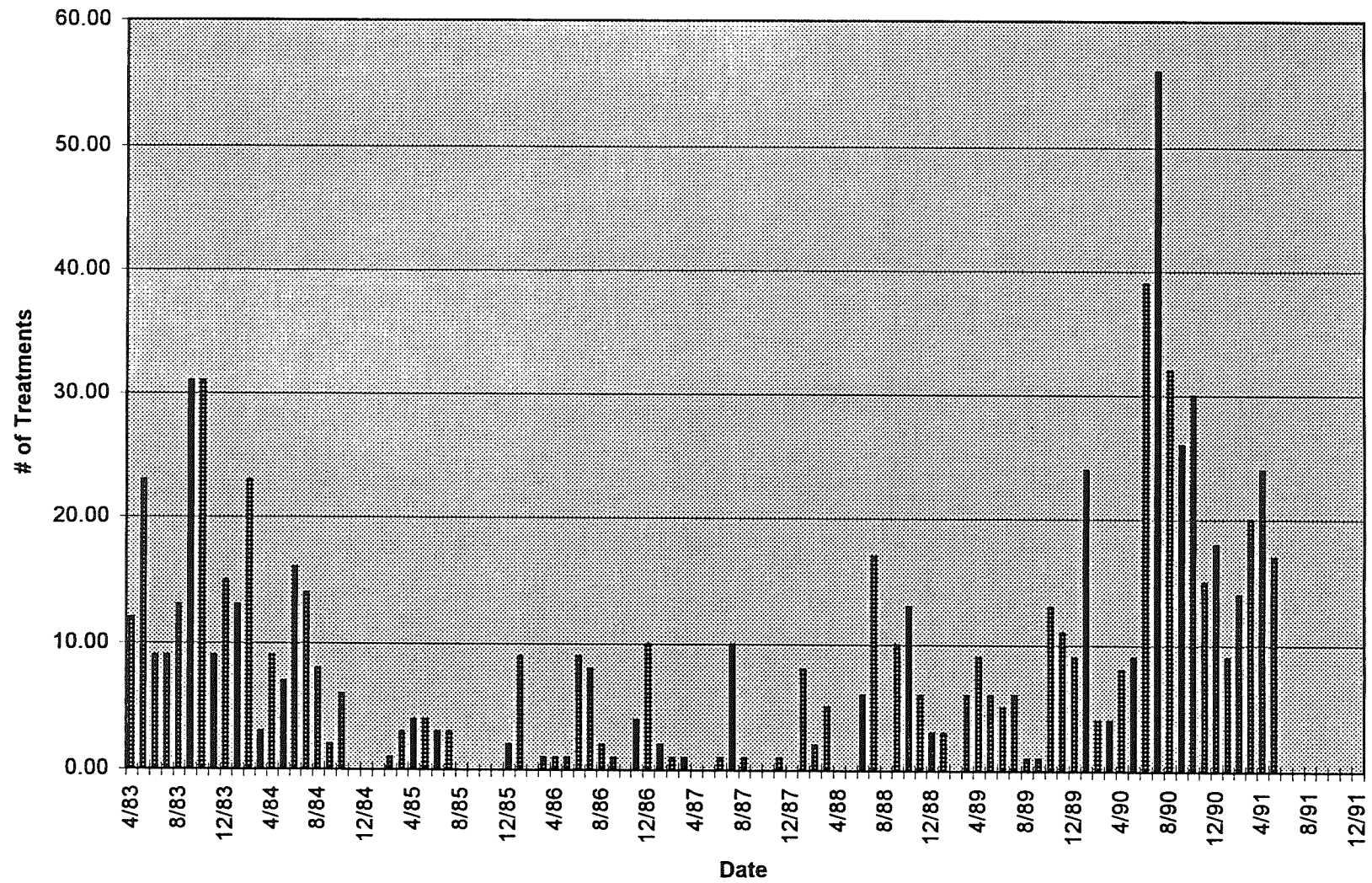


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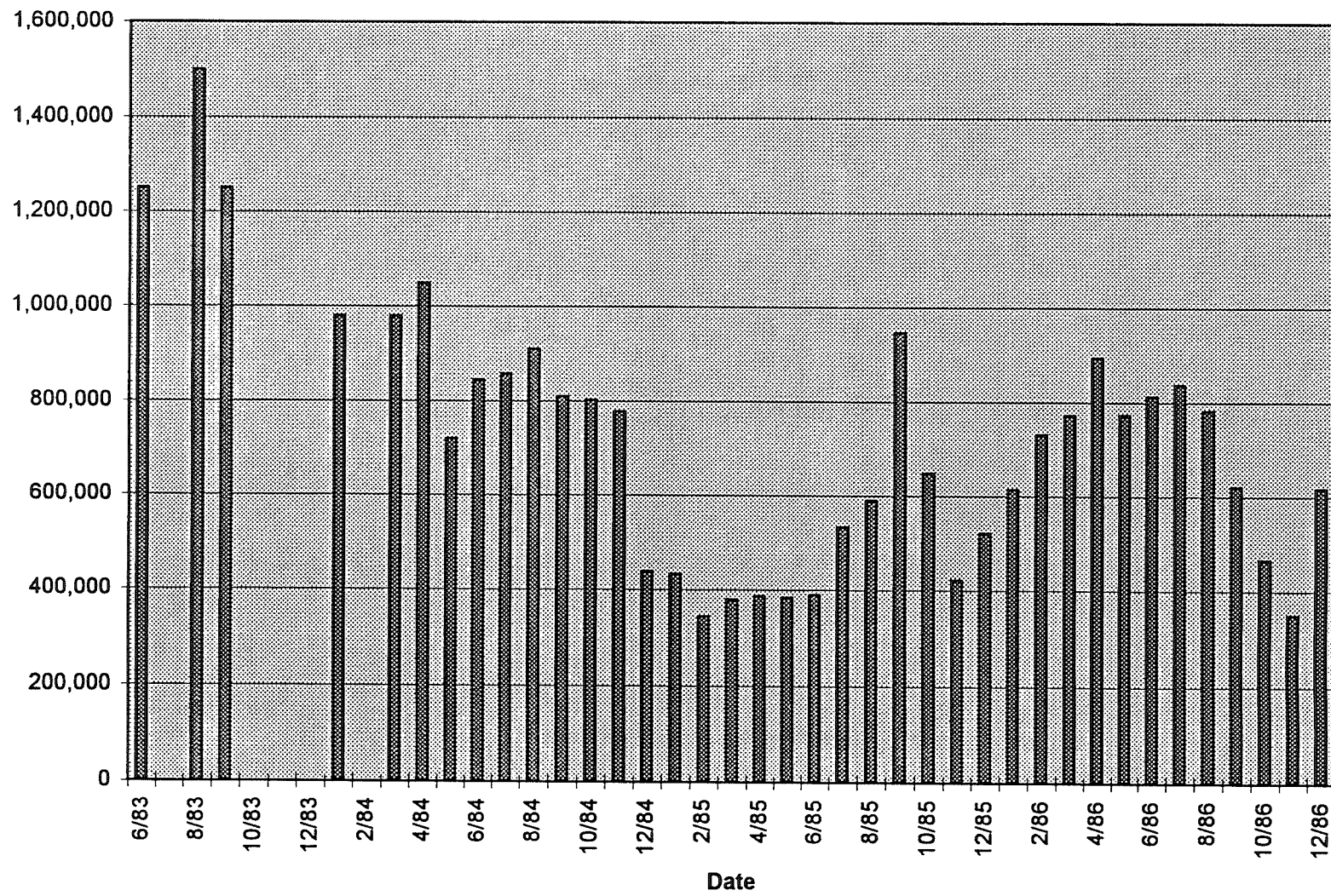
Milk Production on the Kenning Farm



Mastitis Treatments on the Kenning Farm

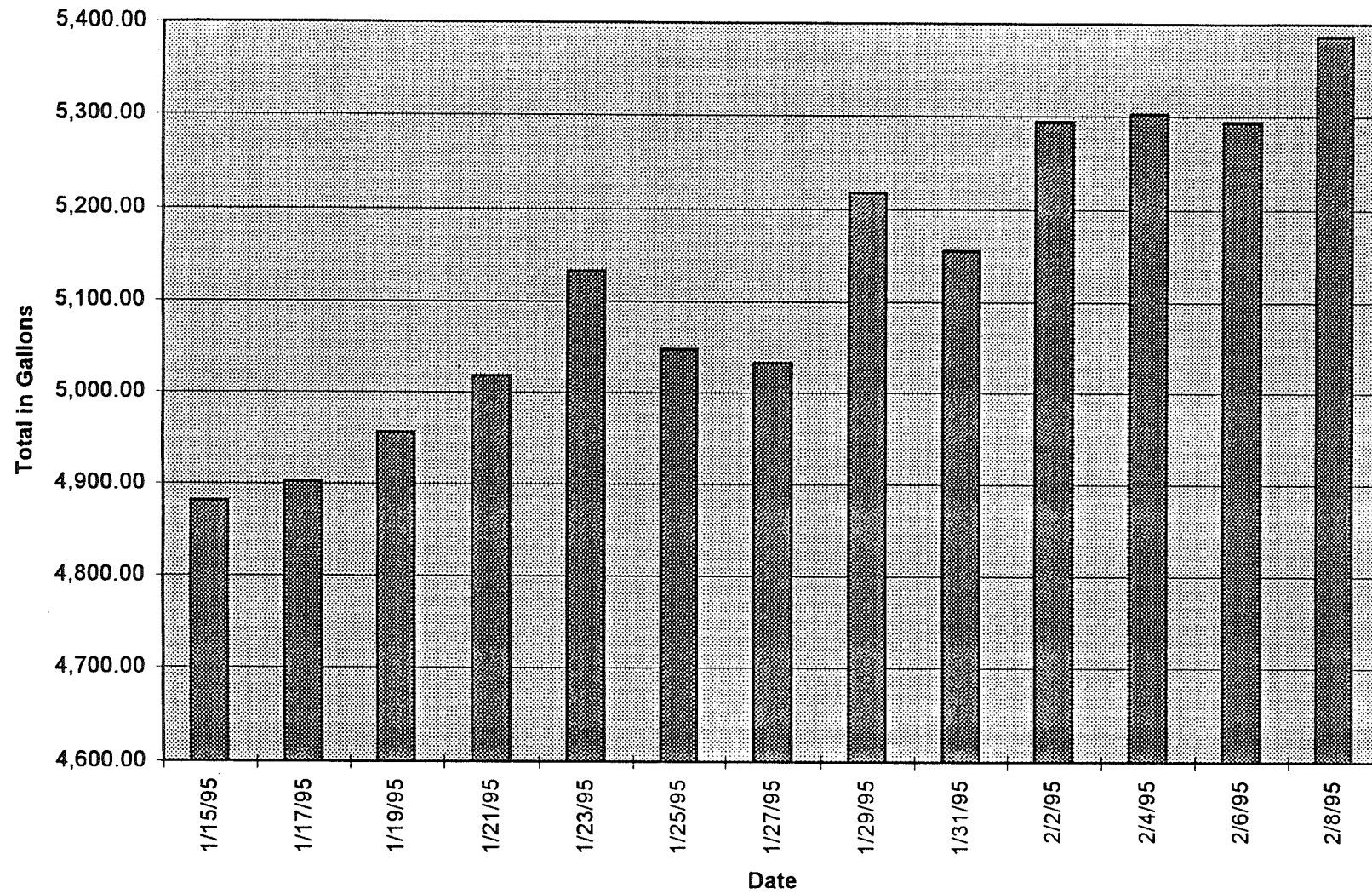


Somatic Cell Count on the Kenning Farm

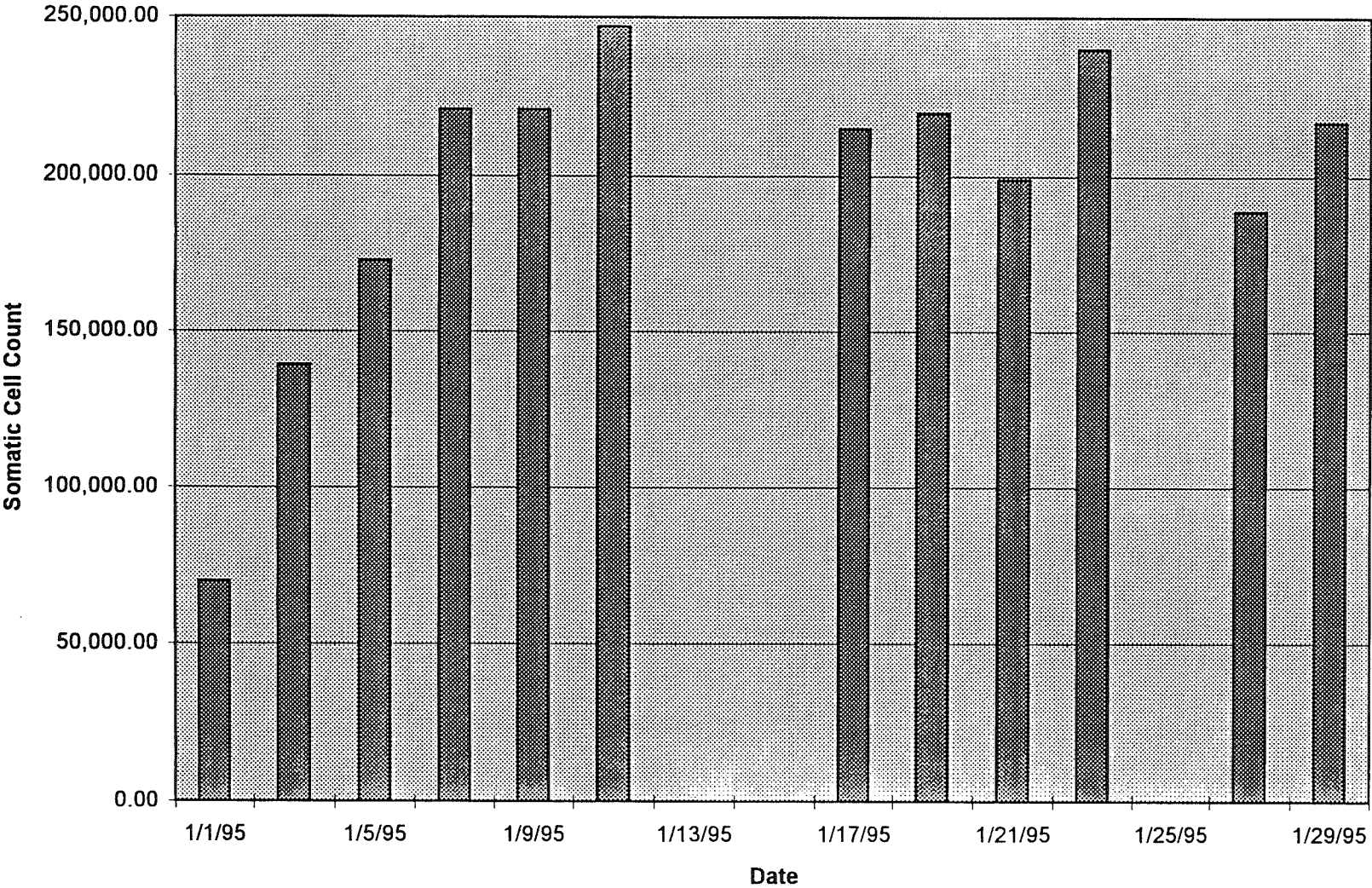


Date	Total Milk Production	SCC
1/1/95		70,000.00
1/3/95		139,000.00
1/5/95		173,000.00
1/7/95		221,000.00
1/9/95		221,000.00
1/11/95		247,000.00
1/13/95		0.00
1/15/95	4,881.00	0.00
1/17/95	4,903.00	215,000.00
1/19/95	4,956.00	220,000.00
1/21/95	5,018.00	199,000.00
1/23/95	5,133.00	240,000.00
1/25/95	5,048.00	0.00
1/27/95	5,033.00	189,000.00
1/29/95	5,217.00	217,000.00
1/31/95	5,156.00	
2/2/95	5,294.00	
2/4/95	5,302.00	
2/6/95	5,294.00	
2/8/95	5,386.00	

Total Milk Production on the Kenning Farm



Somatic Cell Count on the Kenning Farm



1986

Scale Reading and Milk Production on the Kenning Farm

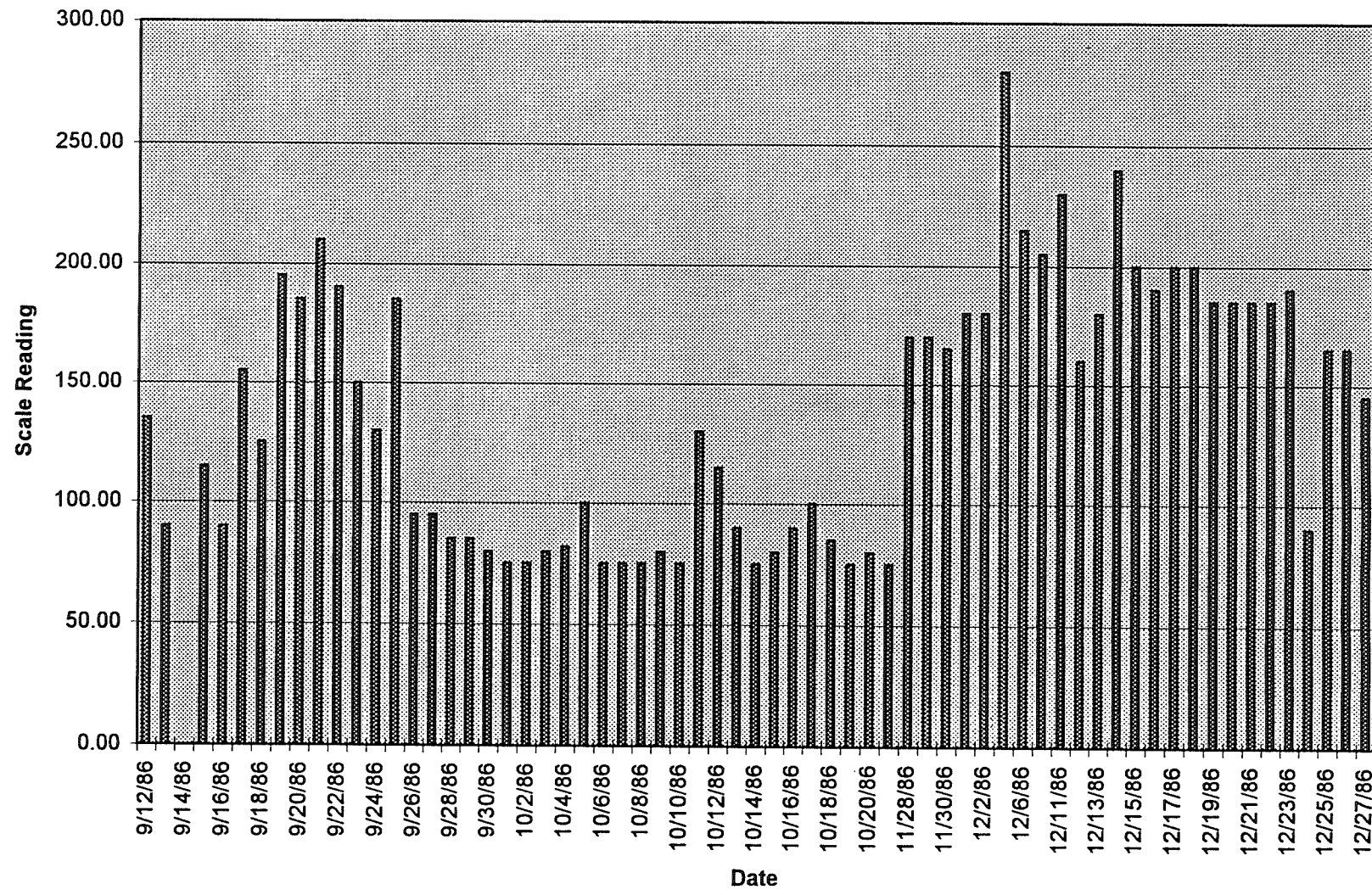
Date	Scale Reading	Milk Production
9/12/86	135.00	
9/13/86	90.00	40.00
9/14/86		
9/15/86	115.00	41.75
9/16/86	90.00	
9/17/86	155.00	41.50
9/18/86	125.00	
9/19/86	195.00	40.00
9/20/86	185.00	
9/21/86	210.00	41.00
9/22/86	190.00	
9/23/86	150.00	39.50
9/24/86	130.00	
9/25/86	185.00	38.00
9/26/86	95.00	
9/27/86	95.00	37.50
9/28/86	85.00	
9/29/86	85.00	37.75
9/30/86	80.00	
10/1/86	75.00	38.25
10/2/86	75.00	
10/3/86	80.00	37.00
10/4/86	82.00	
10/5/86	100.00	37.50
10/6/86	75.00	
10/7/86	75.00	38.00
10/8/86	75.00	
10/9/86	80.00	38.00
10/10/86	75.00	
10/11/86	130.00	37.50
10/12/86	115.00	
10/13/86	90.00	37.75
10/14/86	75.00	
10/15/86	80.00	37.80
10/16/86	90.00	
10/17/86	100.00	38.50
10/18/86	85.00	
10/19/86	75.00	38.80
10/20/86	80.00	
10/21/86	75.00	37.25
11/28/86	170.00	
11/29/86	170.00	40.50
11/30/86	165.00	
12/1/86	180.00	39.00
12/2/86	180.00	
12/5/86	280.00	39.00
12/6/86	215.00	
12/10/86	205.00	

1986

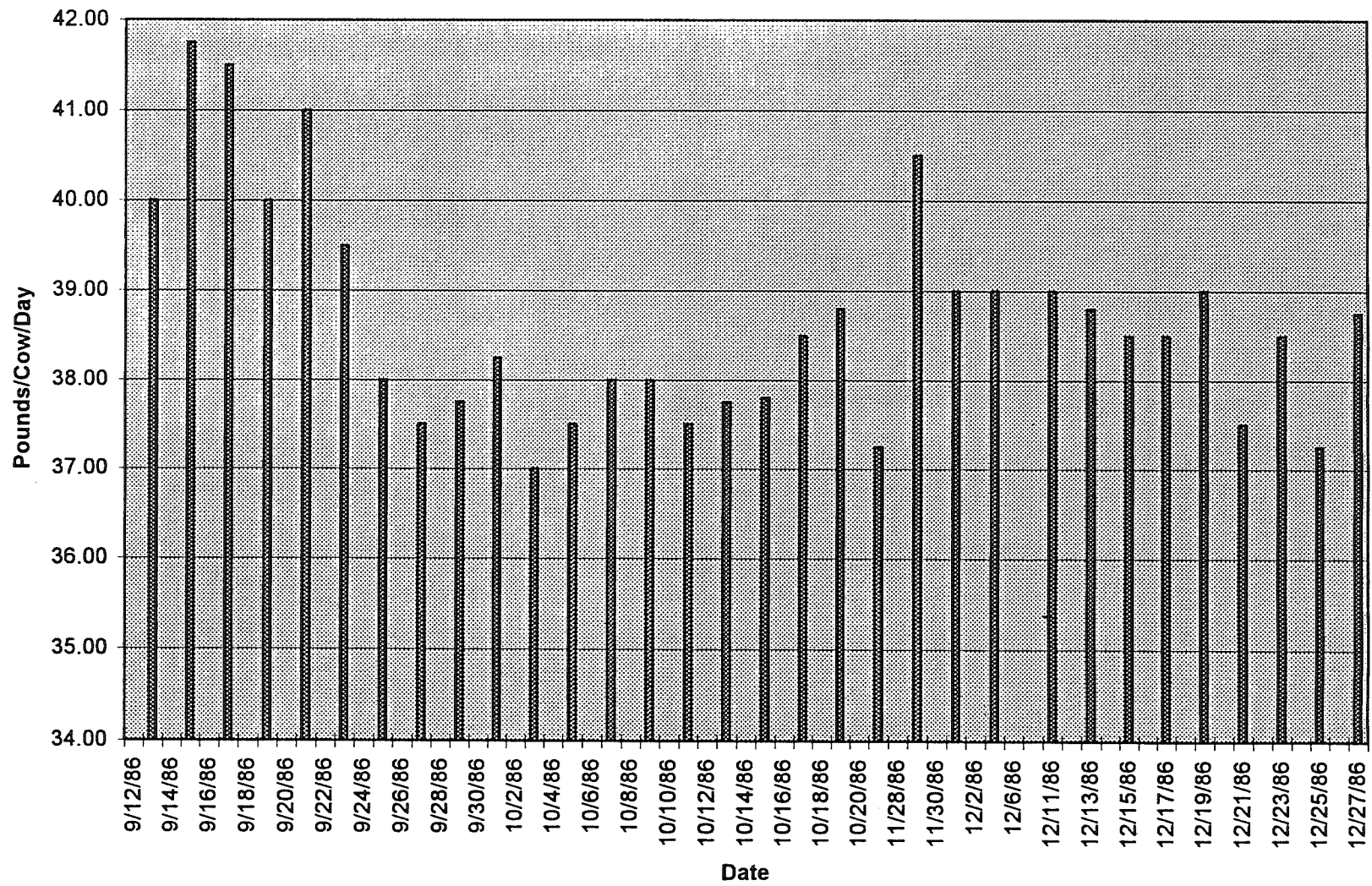
Scale Reading and Milk Production on the Kenning Farm

12/11/86	230.00	39.00
12/12/86	160.00	
12/13/86	180.00	38.80
12/14/86	240.00	
12/15/86	200.00	38.50
12/16/86	190.00	
12/17/86	200.00	38.50
12/18/86	200.00	
12/19/86	185.00	39.00
12/20/86	185.00	
12/21/86	185.00	37.50
12/22/86	185.00	
12/23/86	190.00	38.50
12/24/86	90.00	
12/25/86	165.00	37.25
12/26/86	165.00	
12/27/86	145.00	38.75

Scale Reading on the Kenning Farm



Milk Production on the Kenning Farm



CASE 113

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Poor hair coat
Inflamed sphincter valve
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)

CALVES

Calves rolls tongue

PETS

Dog will not spend any time in dairy barn

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person vision problems (e.g. blurred or heavy eyelids)
1st person problems with breathing
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
1st person allergies
1st person ears ringing

1st person pressure behind the eyes
1st person unexplained general feeling of not being well

GENERAL INFORMATION

FARM CHARACTERISTICS

There are many small ponds and lakes on this farm. Much of the soil is water saturated. There are iron stalls in the barn, and a galvanized water line attached directly to them. The well is grounded. The milkline, which is stainless steel, is physically attached at the top of the stalls but is electrically isolated from all other conductors. The grounding is accomplished through the use of the 8 ft. grounding rods driven into the ground immediately outside the barn. The barn itself was built in 1973 and has both a steel exterior and ceiling- both grounded to the barn ground.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Occasional shocks from water lines or faucets
Noisy telephone requiring frequent service calls or having false rings
Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

This is a life long farm family that has lived on this particular farm for 19 years. They have been dealing with stray voltage problems for the past 13 years.

MEASUREMENTS

Maximum primary neutral to earth voltage: .7 DC, 2.6 AC
Minimum primary neutral to earth voltage: .4 DC, .3 AC
Maximum secondary neutral to earth voltage: .7 DC, 1.6 AC
Minimum secondary neutral to earth voltage: .4 DC, .3 AC
Measurements of current on the primary grounding wires: 225 MA AC
Cow contact voltages: .4 - .7 DC, drinking cup to floor
1.6 AC pipeline to floor
Utility testing found DC voltages would change polarity
0.2 to 0.7 VDC over the width of the stall
Measurements of the cattle themselves reveal also that a vertical potential gradient exists between their hooves and backs.
A DC potential difference on the order of 0.5 volts could exist between one end of the urine stream and the other which could cause a sufficient current flow through the cow to produce discomfort.
Measurements between the hoof of the cow and the conducting part of the milker during the milking process: DC potentials observed 0.2 and 0.5 volts

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Changes in electrical wiring made on farm: installed isolation transformer
installed EGS
installed spark gap

installed new panel in barn, 200 amp
installed surge suppresser
Changes made in electric utility system: larger transformer put in
new line installed 100 yards west of dairy barn to service on
new home at that time, which is now servicing four new homes
Effects on livestock: increase in mastitis
cows kicking off milkers
cows unwilling to enter barn or go into their stall
breeding problems and abortions
swollen joints
Effects on persons living and/or working on farm: discomfort in legs while in barn
fatigue

SPECIFIC CHANGES IN NEUTRAL GROUNDING

Primary neutral: pulled and cleaned transformer and meter pole ground rods
installed spark gap
Secondary neutral: drove additional grounds
installed isolation transformer
installed EGS
After installation of isolation transformer production rose to 2,000 # and cow behavior improved 100%

MITIGATION

This farm has been equipt with a neutral isolator, equipotential plane in barn, electronic grounding system, an isolation transformer and a surge suppresser. With the installation of the isolation transformer there was an increase of 2000 pounds in milk production and a complete turn around in cow behavior, as well as a lowering of SCC. Unfortunately this only lasted about 13 months. Then production slid and behavior and health problems returned. Production dropped dramatically with a loss of nearly 4000 pounds.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

These stray voltage symptoms have been observed for 140 months. After nearly 12 years, 3 isolation devices, numerous electricians, engineers, equipment updates, and expenditures of approximately \$30,000.00, the problems still come and go as fast as cows leave the barn. The actions of the cattle that reveal a problem associated with electricity involve both their continuous bodily functions and their being milked. The eating and drinking habits of the cattle are inconsistent. At times, some will play in their water cups and reluctantly drink the water. For some, eating of grain silage and hay appears to be difficult. When the cattle urinate into the gutter, the urine flow is stopped as soon as it reaches the gutter; consequently, they are conditioned to urinate small amounts and more often.

CONCLUSIONS

There is a serious behavioral, health, and production problem for the cows on this farm.

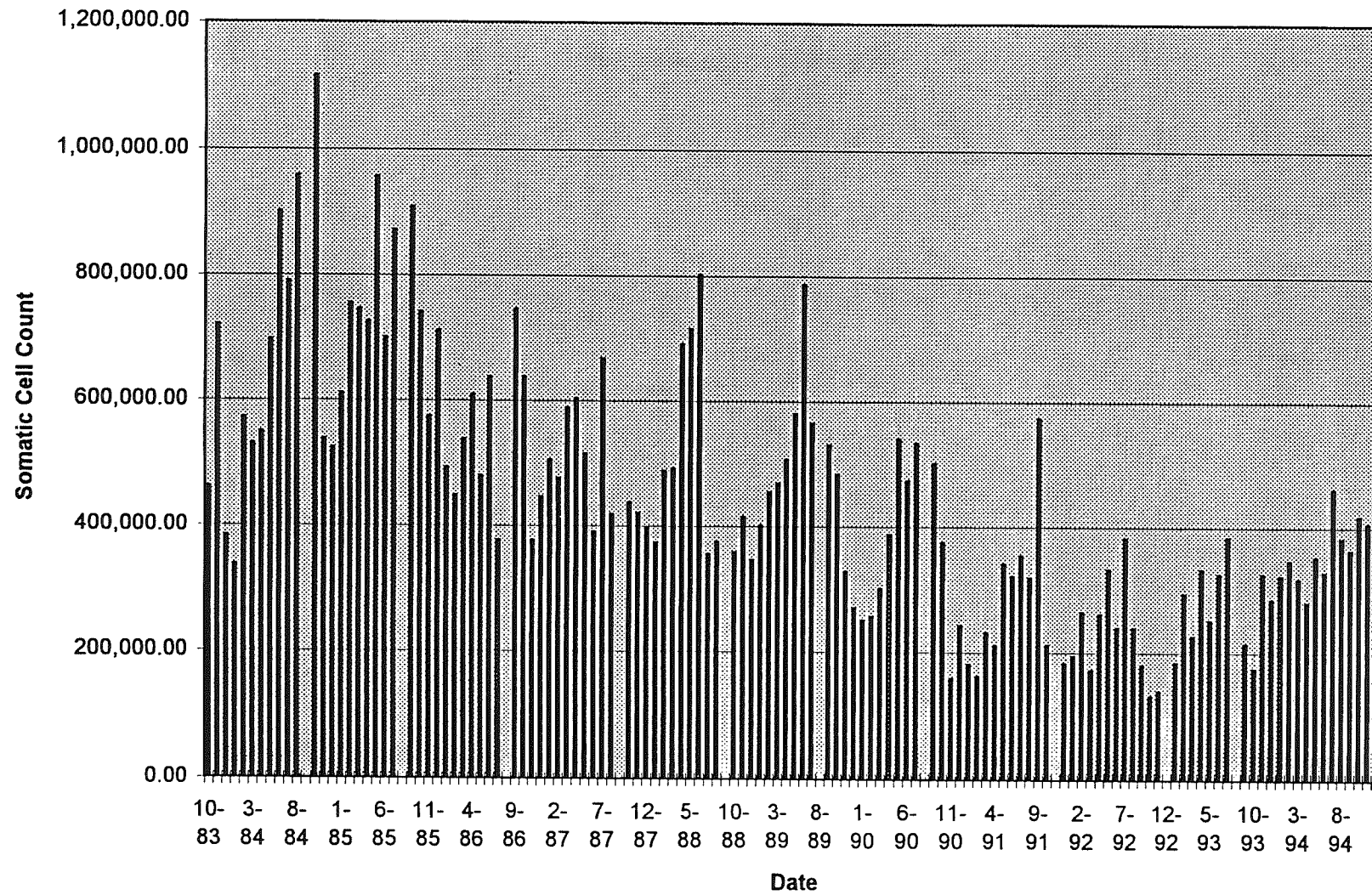
The problems, symptoms and effects are characteristic of stray voltage farms.

With the farm off there are still measures of voltage and amperage in the barn that would have to be coming through the ground from a source off the farm.

Because measurements in the barn show potentials reaching 0.8 volts and sometimes higher, the obvious chemical reactions in the soil alone do not appear to be the only possible source of DC currents.

This farm family has made all the changes required to eliminate the neutral to earth AC currents in their barn. All measurements indicate that, except for the AC coming directly through the earth, AC currents are not present and cannot directly cause the effects noted in the barn. Therefore, it is only logical to conclude that the DC potentials present in the barn are playing an important role in the effects on the cattle.

Somatic Cell Count on the Hagen Farm



CASE 114

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

PETS

Cats leave farm and die

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs
1st, 2nd, and 3rd person frequent headaches
1st, 2nd, and 3rd person frequent flu-like or cold symptoms
1st and 2nd person vision problems (e.g. blurred or heavy eyelids)
1st, 2nd, and 3rd person problems with breathing
1st, 2nd, and 3rd person excessive fatigue
1st, 2nd, and 3rd person frequent irritability
1st, 2nd, and 3rd person often feeling under stress
1st, 2nd, and 3rd person weakness and pain in legs
1st, 2nd, and 3rd person forgetfulness
1st, 2nd, and 3rd person allergies
1st and 2nd person ears ringing
1st, 2nd, and 3rd person pressure behind the eyes
1st, 2nd, and 3rd person unexplained general feeling of not being well
1st and 2nd person rheumatoid arthritis
3rd person (female) feeling bloated/retaining body fluids
3rd person (female) problems with menstrual cycle
2nd person having an illness that medical professionals cannot diagnose
4th person death caused by cancer
2nd and 3rd person treated for ear infections
1st person treated for possible stroke

GENERAL INFORMATION

FARM CHARACTERISTICS

This farm is served by a single phase electric distribution line along the North and East sides of their building site. The entrance to the pad mounted transformer is by means of an open neutral buried cable extending from the east side of their building site to the south of the shop used as a place of business. The primary ground near and on the building site include grounds at two utility poles and over the entire length of the underground cable from the utility pole to the transformer. There is a 400 KV DC electric transmission line located approximately 3.5 miles north of this farm. Also present are buried telephone lines, which will not introduce electrical energy but will often be carriers of currents.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures(sometimes in groups, explosions)

Unusually high rate of battery failure

Noisy telephone requiring frequent service calls or having false rings

Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

This is a life long farm family who has lived on this particular farm for the past 36 years. Beginning about 1979 the family began to experience unusual health effects while living and working on the farm. Health effects have been especially noticeable in the shop.

MEASUREMENTS

A rod was driven into the ground about 25 feet Northwest of the northwest corner of the shop. The rod was not connected by wire conductor to the farm neutral. The resistance of the ground rod was estimated to be approximately 500 ohms. The current was measured with a Swain AC to DC converter and recorded on a Rustrack recorder.

Using the Monitor milligauss meter, the 60Hz magnetic field was monitored and found to be less than 0.05 mg all over the farm yard except near buried cables. In the shop vlues were approximately 0.02 mg except near transformers.

Away from steel buildings the maximum DC magnetic field varied between .605 gauss and .560 gauss. Near the steel buildings these numbers were quite different. In the pole shed the maximum DC magnetic field ranged around .540 guass.

Because of the small values of 60 Hz magnetic fields, no attempt was made to measure AC electric fields. No additional information would have been produced.

The neutral to earth measurements were made in the shop in conjunction with current measurements. The DC measured was .28 volts and the AC ranged from .15 volts with no load to .5 volts with loads.

Utilizing a battery powered oscilloscope, a basic 60 Hz signal, some of the higher harmonics and some additional higher frequencies considered to be primarily radio and television were observed. There was a square wave superimposed on the 60 Hz in one observation. The square wave appeared to have a frequency of approximately 200 Hz.

Response of the DC electric field meter is also shown on the strip chart from the recorder. DC spikes were observed as well as a floor positively charged with respect to the neutral.

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Some additional measurements were made in an attempt to assess the effect on the current going into the earth when 240 VAC loads were turned on. First, the current going into the earth was measured at a ground rod on a pole east of the shop. With essentially no load on, the current going into the earth was 13 ma AC and 6 ma DC. Turning on a 240 volt, 5 Hp load the AC into the earth increased to 25 ma. Second, an electric fence rod was driven into the earth approximately 120 feet West of the rod Northwest of the shop. The AC potential between these two rods increased from 7 to 14 mv when the 5 Hp load was turned on.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

Changes were made in both 120 VAC and 240 VAC loads. 120 VAC loads would cause a certain fraction of the current to go into the earth determined by the resistance of the grounding. 240 loads produced much smaller changes in current going into the earth because no additional current is added to the secondary neutral. The small additional current going into the earth is caused by the direct connection of

the primary and secondary neutrals. DC was also measured with a Swain clamp-on DC ammeter and recorded on a DC recorder. Of significance is the fact that the DC going into the earth changed with the loading, as well. Within this system there could be many reasons for that change including a difference in the manner in which the transformer functioned under varying loads to the conversion of a portion of the AC to DC in the earth.

MITIGATION

On this farm the primary grounds were moved away from the barn. An isolation device was also installed.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

These stray voltage symptoms have been observed for the past 15 years. Observations were also made which associated health effects to be significantly worse on days when there was a southeast wind. In a pole shed which was recently moved to the property it has been observed that no birds will enter or nest within. At a number of locations around the farm yard the battery in a vehicle and batteries in farm machinery will discharge and at times go dead for no apparent reason. Within buildings the same batteries in the same vehicles will remain charged for months. Often the utility power meters are perceived to imply a significantly greater electrical use than is expected compared to other similarly equipped farms. In particular on the north side of the roofs of buildings on the farm, a black deposit is observed. It seems to adhere well to the roof material. Curiously, there has been an alarming number of cases of cancer and heart attacks in this area.

CONCLUSIONS

There are serious human health problems on this farm.

The problems, symptoms and effects are characteristic of stray voltage farms.

Electricity is going into the earth whenever either a 120 VAC or a 240 VAC load is turned on. Current is going into the earth from both the primary and secondary and is present in the ground throughout the farmstead. The ground rods on the primary and the unshielded underground cable provide a relatively low resistant path to earth. Measurements indicate that fact. Because of the location of the transformer, the unshielded line and the shop, it is possible that a portion of the current going into the earth will flow through the earth in the vicinity of the shop as it returns to the substation. Whatever is on the primary neutral, whether AC from the transmission/distribution system or DC from the DC transmission line system, can, therefore be in the earth. In addition, electricity, whether AC or DC, which is in the earth from other sources off the farm, can be drawn to the grounding on the farm as a way to get back to the neutral.

If one assumes that the combined primary and secondary grounding was approximately 25 ohms, the currents measured, going into the earth, were in the range of what one would expect in a multi grounded electrical system. The fact that with no load the current going into the ground on the installed ground rod was small and the changes in current from adding loads were within the expected range, it seems clear that no problems exist in the wiring system on the farm. The fact that the AC magnetic fields were within the expected range also support this conclusion.

Both DC and AC are present in the earth throughout the region. Because of the large cross sectional area available for current flow the magnitudes of these currents are difficult if not impossible to absolutely define. The magnitudes of 60 Hz magnetic fields at large distances from transmission and distribution lines reveal that humans and animals live in EM energies and are exposed to EM energies which come both from direct radiation and from conduction through the earth. These EM energies from conduction

through the earth are a complex array of frequencies ranging from DC, to 60 Hz with many of its harmonics, to spikes made up of multiple frequencies, to radio frequency.

Significant and severe health problems have occurred and are occurring for this farm family which are perceived by them and others as being extremely unusual and as having an environmental cause.

CASE 115

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption (before new line 27# per cow now 1 1/2 years later 50# per cow)

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Breedback difficulties

Somatic cell counts (750,000 to 1 mil before new line now 240,000)

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions--has improved

Average production per cow is only at 39 pounds per day

Water consumption per cow is only at 18 to 20 gallons per day

Health

Swollen legs and joints

Poor hair coat, constant lice problems

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Mastitis: SSC is 600,000

CALVES

Calves having poor survival rate--much better since new line

PETS

Cats sickly with rough, dull and shaggy coats--much better with new line

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die--not since new line

HUMAN HEALTH-improved very much after new line was built, not near as bad

1st person tingling or numbness in arms or legs--before new line

1st person vision problems (e.g., blurred or heavy eyelids)

1st person excessive fatigue

1st person frequent irritability

1st person often feeling under stress

1st person weakness and pain in legs

1st person forgetfulness

1st person allergies

1st person ears ringing

1st person pressure behind the eyes

1st person unexplained nausea
1st person unexplained general feeling of not being well
1st person rheumatoid arthritis
Having an illness that medical professionals cannot diagnose

*other members of the household experienced similar symptoms but that portion of the questionnaire was not filled out

GENERAL INFORMATION

FARM CHARACTERISTICS

ELECTRICAL EFFECTS ON THE FARM

Occasional shocks from water lines or faucets
Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

MEASUREMENTS

Step potential between two contact plates positioned to measure a possible dc potential between front and rear hooves of a cow ranged between --88 and 79 mV (10 and 90%). Readings were generally steady.

South milkline to barn ground: Readings were remarkable steady, ranging between 389 and 436 mV.

South milkline to bar ground: The dc potential between these two points was the only reading that noticeable changed from its "normal" value when milking operations commenced. At times its "normal" value was near 0 mV with a "milking anomaly" of about 200 mV. At other times the "normal" value was near 100 mV with a "milking anomaly" dipping to 0, then rising to about 200 mV during milking. Overall, the range was -1 to 202 mV.

Barn ceiling to contact plate on floor: This measurement was meant to provide an independent measurement of the dc electric field in one portion of the barn. Its range was approximately 0 to -100 mV corresponding to a dc field of 0 to -33 mV/meter (mV/height). This is a very small electric field compared to a fair-weather electric field outdoors on the order of 100 V/meter. This reading agrees with spot checks of E with a field mill.

Remote ground to ditch ground: The dc potential between these two distant grounds ranged between 63 and 249 mV and was generally steady.

Barn ground to ditch ground: Range, -221 to -16 mV, generally steady.

The only anomaly noticeable correlative with milking activities was the dc potential on the south milkline (detailed above). The only anomaly possible correlative with operating the barn on generator power was the dc potential on the south milkline (same as above). This observation remains in doubt owing to the fact that operating on generator power coincided with milking in every case and this potential varied during milking consistently regardless of the barn power source.

An accident in the spring tore off one of the ground wires. The measured voltage between the wire coming down the pole to the ground rod was 700 volts. The utility company said it was just static electricity and wouldn't hurt anything, but the cows were affected.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Through a long and hard fight, Senators, Representatives, and the Public Utilities Commission helped get the utility company to build a new Delta line to the farm from across the highway. When it was completed, things turned around immediately. Two days after the new line was built, a first calf heifer came in strong heat. She had been fresh for six months and never showed heat. The next morning another heifer came in heat, also fresh for six months and never showed heat. At that time there were seven pregnant cows out of 44 and all open cattle started coming in heat. It took three months before any of the cows started to settle. Milk production came up steadily after the new line was installed.

Things kept getting better for eight months. It was at that time that the utility company put lightning arresters on the top wire and grounded every pole of their main distribution line across the rack. That's when everything started to fall apart again.

It's as bad in the barn now as it has ever been. Five cows were lost. One heifer died one month after she came fresh. Another heifer had to be put down because she could not get up. Two heifers came fresh and one had mastitis and after four days she had a hard time getting up. There are three more heifers in the barn that are stiff. All of this is because of ground current. The cows are very restless and it is not unusual for the cows to kick the milk machine off four times before they are milked out.

The average production per cow is only at 39 pounds per day. There are 52 stalls in the barn and nine of those are empty. The water consumption per cow is only at 18 to 20 gallons per day. They should be drinking at least 30 gallons of water a day each.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

Symptoms observed for 12 years

Human and animal symptoms occur within the same time frame

New line was built in July 26, 1991. There was an immediate change. Production went from 27# per cow to 51# per cow. Calves are doing much better. They feel much better. They are still experiencing: restless cows, cows not showing heat, heifers needing help getting up. They are also still measuring 1 volt DC from cement at back legs to water cup.

The farm appears well managed with a good feed program and obvious attention to cow comfort and facility's maintenance. I have no specific information or recommendation related to the high somatic cell counts.

This is a well-managed Holstein herd that over the years has had quite a few health and production problems with no obvious cause. Voltage is suspected as being at least in part responsible. It is noteworthy that in the past he was able to temporarily clear up these problems by cutting the ground cables along the power distribution line to his farm. This, however, has posed some legal ramifications which have precluded him from continuing this practice. The farm is within half a mile of the center of the city, which may be a reason why more current is found here. As a result he has used many different techniques, including radionics and hydrogen peroxide treatments, with varying degrees of success in order to insure the health of the herd.

The water quality report reveals no significant problems and the ration is balanced adequately for the average cow.

The blood electrophoresis readings, however, show a very significant lack of albumin and an elevation of globulin, indicating stress from chronic inflammation or a nutritional problem or both. The computer does not feel that the cows could eat the amount of dry matter required to produce 50# milk as stated on the printout. The printout feels that the expected D.M. (dry matter) intake is a pound and a half less than what is required to give the average cow a balanced ration. As a result, they may not be getting the proper amount of protein or energy or calcium which are not in abundance at this level. The albumin levels were significantly lower for both healthy cows and unthrifty cows, with not much difference between the two. This may point to a nutritional inadequacy. The globulin levels on the whole seemed more significantly raised on the so called unthrifty cows from the healthy animals, but not every case, and the reason for this can only be speculated on.

The range and average of the albumins in this herd are low, hypoalbuminemia. With only one animal normal. Was this individual of a different age or at a different stage of lactation? The significance is a generalized nutrition problem or a cause for not eating properly -- stray voltage?

This set of data can only stimulate a desire for an in-depth study with further information to figure out the problems in the herd.

Two veterinarians from the University came out to check the herd and found 12 pregnant cows out of 52, and they found no infections or no cystic ovaries. They found the herd in good health. They took blood and urine samples and stool cultures. They found nothing wrong. They checked the feed ration and found nothing wrong with that. Some of these cows were bred seven or eight times. Some were bred by someone who has been inseminating for 25 to 30 years and some were bred by the farmer himself.

CASE 116

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

ADDITIONAL SYMPTOMS

Cows moving and pulling back in stations

Cows circling in cattle yards

Cows dieing in certain areas

Cows reluctant to cross ditches in pasture

Cows milk or give more milk in corn stalks in field

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

Goat responds to voltage in barn and down driveway by jumping in barn and not going in barn or down driveway

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs

1st, 2nd, and 3rd person frequent headaches

1st, 2nd, and 3rd person frequent flu-like or cold symptoms

1st, 2nd, and 3rd person vision problems (e.g. blurred or heavy eyelids)

1st and 2nd person excessive fatigue

1st, 2nd, and 3rd person frequent irritability

1st, 2nd, and 3rd person often feeling under stress

1st person weakness and pain in legs

2nd and 3rd person forgetfulness

1st, 2nd, and 3rd person allergies

1st, 2nd, and 3rd person ears ringing

1st person pressure behind the eyes

1st, 2nd, and 3rd person unexplained nausea

1st, 2nd, and 3rd person unexplained general feeling of not being well

1st and 2nd person rheumatoid arthritis

2nd person (female) feeling bloated/retaining body fluids

2nd person (female) problems with menstrual cycle

1st, 2nd, and 3rd person having an illness that medical professionals cannot diagnose

blood and bacteria in urine

GENERAL INFORMATION

FARM CHARACTERISTICS

This farm is located near a large aquifer. Presently, the neutral and ground wires on the secondary side are connected together at the transformer pole. Also on the primary side, the ground and neutral wires, separately, go out to the road but are connected together at both the transformer pole and on the other poles between the transformer and the road. In this case the ground wire on the primary side serves the sole purpose of decreasing the resistance of the neutral wire. The only electrical equipment in the barn is the milking system.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)

Unusually high rate of battery failure

Radio and TV set failureIncreasing motor burnouts

Occasional shocks from water lines or faucets

Noisy telephone requiring frequent service calls or having false rings

Accelerated corrosion of well casings or other buried pipes

Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

This is a multi-generational, life long farm family. They have lived on this particular farm for 37 years. This farmer has received state awards as well as an American Farmer Degree. Farming a variety of animals, they started their dairy operation 10 years ago.

MEASUREMENTS

60 Hz magnetic fields were low throughout the cows environment during periods of low electrical use in the barn. These fields were in the range of 0.1 mG. During milking the magnetic fields were raised above 0.1 mG up to 0.2 mG and, of course, higher near electrical equipment. Away from the barn the 60 Hz magnetic field was less than 0.1 mG increasing near distribution lines. The 60 Hz magnetic field was never zero at any location on the farm.

Currents on grounding wires varied with location and time of day. On the feeder line for the farm the current on the primary grounding wires ranged from 50 to 70 mA between 2 and 3 PM and 175 to 200 mA at approximately 5 PM. On the secondary grounding wire at the transformer pole, the current was 12 mA at approximately 5 PM. Near the substation currents on grounding wires ranged from 250 to 325 mA between 2 and 3 PM. In addition the underground electrical cable which provided electricity for the rural water wells produced a significant field at the surface of the earth. Other buried materials could also have been carrying current and producing magnetic fields but nothing else could be identified. The fact that a magnetic field was produced by the underground cable, however, implied an imbalance between the magnitudes of current on the neutral and the phase wire.

Direct currents (DC) were measured at a number of locations. DC voltages and currents were present between various points in the barn. Up to 0.8 VDC existed between points in the barn with 0.37 VDC between the milkline and the floor of the barn. The ground wire connected to the well had a maximum of 40 mADC which varied with the turning on and off of the electricity on the farm. The electricity on, increased the current.

The currents producing the 60 Hz magnetic fields were observed to have a complex wave form indicating significant levels of harmonics in the currents. An oscilloscope with a coil was used for this observation. In addition, higher frequencies were present on the milkline which had frequency components of approximately 1 and 5 MHz.

AC voltages were measured between the milkline and a bare wire connecting to the well and secondary neutral. With only the lights on in the barn there was 0.384 VAC between these points. The value went to 0.427 VAC after the lights were turned off and down to 0.037 VAC after the electricity to the barn was turned off. When the electricity to the entire farm was turned off, the voltage was at 0.052 volts. Between the floor and the milk line, the voltage was 0.029 volts with lights and fan on in the barn and 0.054 volts with the electricity turned off on the farm. During milking the voltage between the milkline and the wire connected to the well ranged from 0.045 to 0.060 VAC when the transfer pump was off and from 0.5 to 0.6 VAC when the milk transfer pump was operating. Turning on 240 VAC loads in the barn also would affect the voltage measurements.

While the cows were being milked, the wire connecting the ground bar in the circuit breaker box to the well had about 1700 mAAC of current and this current did not change much with turning on and off of lights in the barn.

Voltage measurements were made between ground rods on the farm which were not connected to any primary or secondary neutral. AC voltages were always present whether electricity were on or off but would change in value.

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Installation of an arrester. Noticable changes only for short time period.

Extensive rewiring done including installation of a four wire system. Problems still occurring.

Changed the vacuum system in the barn. There was no noticeable change in cow behavior or pounds of milk.

Changed the pulsation system in the barn. Did notice faster milking time, which is what the system is designed for. Cows behavior same, still kicking off milkers and are very jumpy at variuos times.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

Presently, the neutral and ground wires on the secondary side are connected together at the transformer pole. On primary side, ground and neutral wires, separately, go out to the road and are connected at transformer pole. The ground wire on the primary serves the sole purpose of decreasing resistance of the neutral.

MITIGATION

Installation of an arrester .

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

In the barn the only electrical equipment is the milking system. There is no automatic barn cleaner nor powered feeding equipment. In addition the cows are exposed to no metal materials except the pipeline and stall dividers. The cows, however, have no direct contact with the conductors unless they desire to touch the stall dividers. The animals cannot be shocked as traditional stray voltage would suggest because the cow is in contact with no conducting material other than the floor. Thus, this suggests the use of the earth, by the utilities, to carry the neutral return current, of which the electricity will find its way to the barn from off the farm.

CONCLUSIONS

There is a serious behavioral, health and production problem for the cows on this farm.

The problems, symptoms and effects are characteristic of stray voltage farms.

Cow contact voltages in this barn are far more limited than in barns with water cups and steel stall dividers which the cows could touch. The cows primary exposure to electricity would be from contact with the floor or earth, from contact with the milker and from induced currents resulting from electric and magnetic fields.

Measurements indicate that electricity is in the cows' environment in the barn and at other locations even with the electricity turned off on the farm. The AC magnetic fields remain at about the same levels whether the farm electricity is off or on.

With the addition of 240 VAC loads, the measured voltages decreased in the barn. Since 240 VAC loads add no current to the secondary neutral the noted effect must be caused by the current passing through the earth to the secondary system and the barn. The voltage measured in the barn before the 240 VAC load was turned on was probably mostly from a distant source of different phase that interfered with the voltage on the primary neutral wich resulted from the turning on of the 240 VAC load.

CASE 117

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CONDITIONS BEFORE ISOLATION

CATTLE

Behavior

Cows reluctant to enter barn and/or parlor
Cattle were wild in the parlor
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production,
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts, rose to over 1,000,000
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Inability to maintain weight in cold weather
Inflamed sphincter valve (even among un milked heifers)
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Dog has stiff joints
Dog becomes skittish at different points of property

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs
1st, 2nd, and 3rd person frequent headaches
3rd person frequent flu-like or cold symptoms
1st, 2nd, and 3rd person vision problems (e.g., blurred or heavy eyelids)
1st, 2nd, and 3rd person excessive fatigue
1st, 2nd, and 3rd person frequent irritability
1st, 2nd, and 3rd person often feeling under stress
1st, 2nd, and 3rd person weakness and pain in legs
1st, 2nd, and 3rd person forgetfulness
1st, 2nd, and 3rd person allergies
1st, 2nd, and 3rd person pressure behind the eyes
1st, 2nd, and 3rd person unexplained nausea
1st, 2nd, and 3rd person unexplained general feeling of not being well
1st, 2nd, and 3rd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
1st person nerve problems--hands lock up, loss of sense of feeling

/

CONDITIONS AFTER ISOLATION

CATTLE

Production

Breedback difficulties

HUMAN HEALTH

Unexplained nausea
Rheumatoid arthritis
Nerve problems: hands lock up, little sense of feeling

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm is located in an agricultural region away from any home or manufacturing development. The water table is high on the farm. Standard milking equipment is used in conjunction with a special circular parlor which required the cows to move in a circular path while being milked. The farm family designed and built the unique parlor system. Cows were housed in pens outside the milking barn. The transformer was mounted on a pole in the farm yard within 20 to 40 m from buildings. No large transmission lines were near the farm and no natural gas nor oil pipelines were in the vicinity. An isolator was in operation on the farm.

ELECTRICAL EFFECTS ON THE FARM - BEFORE ISOLATION

Noted were:

Unusual failure rate for incandescent bulbs
Unusually high rate of battery failures
Radio and TV failures not related to lightening storms

Increasing motor burnouts
Occasional shocks from water lines and faucets
Noisy telephone
Unexplained fluctuations in electric bills.

ELECTRICAL EFFECTS ON THE FARM - AFTER ISOLATION

None noted

HISTORICAL BACKGROUND

This is a life long farm family, they have lived on this particular farm for 43 years. . .

MEASUREMENTS

Measurements were made at a number of locations on the farm to determine the exposure of the cows to the neutral voltage whether in the parlor or drinking water in the pens. Using a ground approximately 30 ft from the neutral grounding, the voltage to the primary neutral ranged between 1.5 and 4.0 volts AC, and to the secondary neutral ranged from 0.090 to 0.170 volts AC. These measurements would indicate that the isolation unit is functioning as it should. DC neutral to earth voltages were in the range of 0.10 to 0.30 V. AC currents of at least 250 mA were in the grounding wire on the distribution pole north of the farm. Currents were also present in other primary grounding wires. Direct currents were in the range of 100 to 150 mA on the primary grounding wires. Currents in the water pipes in the barn were at 10 ma AC before milking and 8 ma during milking. Electrical use in the barn was limited to the milking operation. Exposure to the ground-neutral conductor would allow for shock voltages to the cows of less than 0.2 volts AC. AC Cow contact voltages in the barn were less than 0,3 volts at all points measured. AC magnetic fields were at the 0.1 to 0.2 milligauss level in the barn except near operating motors and electronic equipment.

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

SPECIFIC CHANGES IN NEUTRAL GROUNDING

MITIGATION

An isolation device has been installed. Before isolation the shock voltage for the cows could have been as high as 4 volts AC assuming conditions were the same before isolation as they are today. All research completed to date would anticipate the shock current possible under non-isolation conditions to affect the behavior of the dairy cows. And indeed there were the behavioral characteristics among the cows while in the milking parlor, these effects are: unwillingness to enter the parlor, kicking at the person doing the milking, attempting to jump out of the parlor, kicking off milkers, uneasiness, etc. The installing of the isolation unit reduced the potential exposure by more than 90%. The installing of the isolation unit coincided with the beginning of a steady improvement in the behavior, health and production of the cows on this farm.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

This farm family experienced health and production effects in their dairy herd that seemed to correlate with the installation of a new parlor milking system. Standard milking equipment is used in conjunction with a special circular parlor which required the cows to move in a circular path while being milked. The farm family designed and built the parlor. This farm family had the skills and training to develop and construct the unique system. When they began using the parlor the traditional set of behavior, health and production effects occurred in their dairy herd.

CONCLUSIONS

There is a serious behavioral, health and production problem for the cows on this farm.

The problems, symptoms and effects are characteristic of stray voltage farms.

The dairy operation, even during the milking process, has little, if any, effect on electrical current reaching the earth.

Exposure to the ground-neutral conductor would allow for shock voltages to the cows of less than 0.2 volts AC.

CASE 118

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

Ringworm doesn't respond to treatment

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

Dog died in shed for no apparent reason (young dog)

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st and 2nd person frequent headaches
1st person vision problems (e.g., blurred or heavy eyelids)
1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
1st and 2nd person allergies
1st person ears ringing
1st and 2nd person pressure behind the eyes
1st person unexplained nausea
1st person unexplained general feeling of not being well
Six week pregnancy miscarriage

EQUIPMENT OR MACHINERY PROBLEMS

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure (battery exploded when driving in field under power line)
Increasing motor burnouts
Occasional shocks from water lines or faucets
Noisy telephone requiring frequent service calls or having false rings
Accelerated corrosion of well casings or other buried pipes
Unexplained fluctuations in electric bills
Telephone cut off

OTHER INFORMATION

Symptoms observed for 41 months
Human and animal symptoms occur within the same time frame

This farm family lost over half of their herd and are in Chapter 12 because of stray voltage. They had as high as 19 volts on primary neutral. They moved over 60 miles to get away from stray voltage and still have some problems.

CASE 119

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts (SCC Ave. 1980-88 1,000,0000)

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Dog has stiff joints
Dog becomes skittish at different points of property

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs
1st, 2nd, and 3rd person frequent headaches
1st, 2nd, and 3rd person frequent flu-like or cold symptoms
1st, 2nd, and 3rd person vision problems (e.g., blurred or heavy eyelids)
3rd person problems with breathing
1st, 2nd, and 3rd person excessive fatigue
1st, 2nd, and 3rd person frequent irritability
1st, 2nd, and 3rd person often feeling under stress
1st, 2nd, and 3rd person weakness and pain in legs
1st, 2nd, and 3rd person forgetfulness
1st, 2nd, and 3rd person allergies
1st, 2nd, and 3rd person ears ringing
1st, 2nd, and 3rd person pressure behind the eyes
1st, 2nd, and 3rd person unexplained nausea
1st, 2nd, and 3rd person unexplained general feeling of not being well
1st, 2nd, and 3rd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids

HISTORICAL BACKGROUND

Has lived on his farm for 38 years
Is a farmer, male and in his 30's

MEASUREMENTS

Maximum primary neutral to earth voltage is 0.5 DC and 4-5 AC
Minimum primary neutral to earth voltage is 0.25 AC
Maximum secondary neutral to earth voltage is 1.0 DC and 4-5 AC
Minimum secondary neutral to earth voltage is 0.1 AC
Measurements of current on the primary grounding wires is 10 Amps
Measurements of current on the secondary grounding wires is 10 - 250 MA
Equipotential plane in parlor is 0.2 DC and 0.2 AC
Gauss meter - milli gauss always changing - low at start of milking, then higher till end of milking

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The changes made in the electrical wiring on the farm are as follows: ground rod relocation (keep ground paths away from cows), complete rewiring and upgrade on farm (no help) and shield (not copper wire circling barn and cow area (can not be complete circle). Power source direction changes. Production is up and down, substations changes affect production and S.C.C. and B.F. frayed wires cause lot of trouble. This helped when fixed. There is an electrical transmission line been added in the 1970's and no recent changes in the natural gas or oil pipeline near the farm.

The changes on the farm is that the somatic cell count and lower production. Also the power line displace and destroy oxygen (source of energy for animals, people and plants). The changes made in human health is that there was a slight weight gain. The human body retains fluids to shield against electrical interference after available carbon is over loaded. (used up) Also motors burnt out and lot of solenoid failure (control systems and pulsators).

SPECIFIC CHANGES IN NEUTRAL GROUNDING

Primary neutral - neutral isolator, two times 1988 and 1992 (no good)

Secondary neutral - separate grounds and neutrals (no good)

Electrical equipment - relocate ground rods

The changes noticed from the above changes is that loss of energy, fatigue irritable, reduced crop quality, drop in production, high somatic cell count and keeping animals and people out of return ground path helps.

Neural isolator made it worse because all the energy returns to it's source. Neutral isolators do not work in capacitance situations.

Equipotential planes do not protect against magnetic fields.

EGS system requires low resistant grounds, which is the problem in the first place .(lack of ground)

Energy wheels rebalance energy fields of a given area. Slow but sure pyramids. If built properly they work, but do not work in strong unbalanced electric fields.

The neighbors electric panel blew up in 1993 and again on 10-2-94. After change in the area, two miles away.

CASE 120

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs

1st and 2nd person frequent headaches

1st and 2nd person frequent flu-like or cold symptoms

1st, 2nd, and 3rd person vision problems (e.g., blurred or heavy eyelids)

1st and 2nd person problems with breathing

1st and 2nd person excessive fatigue

1st and 2nd person frequent irritability

1st and 2nd person often feeling under stress

1st and 2nd person weakness and pain in legs

1st and 2nd person forgetfulness

1st and 2nd person allergies

1st and 2nd person ears ringing

1st and 2nd person pressure behind the eyes

1st and 2nd person unexplained nausea

1st and 2nd person unexplained general feeling of not being well

1st and 2nd person rheumatoid arthritis (arms hurt all the time)

Have fatty tumors but not diagnosed
Too afraid to go to doctor for occurrence of malignant body tumors
1st person (female) feeling bloated/retaining body fluids
1st person (female) problems with menstrual cycle (completely irregular)
1st and 2nd person having an illness that medical professionals cannot diagnose
1st person occurrence of heart related ailment (high blood pressure)
1st person circulation problems

GENERAL INFORMATION

FARM CHARACTERISTICS

They have a radar range and regularly use a personal computer.

ELECTRICAL EFFECTS ON THE FARM

Bulbs always burning out
Radio and TV set failure (non-lightening related)--gone through 5 TV's in 8 years
Occasional shocks from water lines or faucets (bulk tank--power company told her I should be analyzed as not able to be felt by human)
Noisy telephone requiring frequent service calls (blame it on wet) or having false rings (all the time)
Accelerated corrosion of well casings or other buried pipes
Unexplained fluctuation in electric bills (for years)

HISTORICAL BACKGROUND

They were to the point where they were financially doomed because of loss of milk and replacement of milk cows. They tried to get the electric company to help, after hiring an analyst they did come and isolate. They were hoping this was the answer. After about 2 months, their cell count was as high as or higher than before the electric company came. They felt helpless and yet have tried to find help.

At the present, they have lost everything and cannot get any help. The power company says the farm has no stray voltage problem. The FmhA says they are poor managers so they are losing their farm. The farmers shut down the barn a year ago so as not to spend much time in the barn. They worked for 32 years to put it together.

MITIGATION

They tried to get the electric company to help, after hiring an analyst they did come and isolate. They were hoping this was the answer. After about 2 months, their cell count was as high as or higher than before the electric company came.

CASE 121

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Appeared to be under a great deal of stress
Many did not want to enter their stalls

Production

Well below genetic capability
Peaking in first month of lactation
Uneven or poor milk letdown

Health

Sudden outbreaks of mastitis which could not be successfully treated with antibiotics
High SCC
Inability to breed successfully

CALVES

PETS

HUMAN HEALTH

GENERAL INFORMATION

FARM CHARACTERISTICS

In every way this is a well-managed dairy operation. Those involved have been in the business for many years and are well qualified to understand problems in dairy herds. The cows are always on concrete whether inside or outside the barn. The young stock begin in hutches and progress to two sheds--the first with a concrete floor and the second with a slatted floor. The dairy barn is a frame structure with concrete floor, steel posts and dividers, stanchions, milk line and manure handling system. The milk line, stalls and water system appear to be tied together electrically and grounded. The electrical distribution system is underground into the farm and mainly underground on the farm. The farm has an isolation transformer located at the meter pole. The grounds for the utility side and the farm side of the isolation transformer are separated by about 5 feet. The entire electrical system appears to be functioning appropriately. An oil pipeline is approximately 1 mile North of the barn, a 500 Kv DC line is 10-15 miles South of the barn and a radio transmitter approximately 2 miles East.

ELECTRICAL EFFECTS ON THE FARM

HISTORICAL BACKGROUND

Before 1981 or 1982 the dairy operation was progressing as expected. Genetics was improving, production was increasing each year and herd health was normal. In approximately 1982, changes were occurring which indicated that some problem or problems were developing. The changes could have been happening in a slow subtle manner.

MEASUREMENTS

AC and DC voltages to which the cows could be exposed were measured with a digital multimeter. Measurements were made both when the cows were out and when they were in the barn and with no load and full load on the electrical system.

AC- Neutral to remote ground .133 V (3:30 PM) No change with all equipment on in barn but increases were noted at time of milking.

AC- Plate on rubber mat to water cup .003 V (3:30 PM) to .03 V at milking. Difference did not appear to be caused by operating electrical equipment on the farm.

AC- Between two remote grounds approximately 100 ft apart .050 V (4 PM). No change with all electricity turned off on farm.

DC- In all measurements DC voltages were present. The actual numbers do not have a great significance because of the many different metals and the galvanic effects. Significant, however was the fact that the DC voltages showed large variations from one stall to the next and were continuously changing (increasing and decreasing from 2 to about 20 %). DC appeared to be affected by the turning on and off of electrical equipment. DC from floor to SN changed when cows entered the barn.

Between the PN and SN the voltage was 0.5 VAC with the power on and 0.01 VAC when the power to the farm was turned off.

AC electric and magnetic fields were measured at various places around the farm. AC magnetic fields were less than .1 milligauss except near operating electrical equipment. AC electrical fields were low except at the surface of all barn materials and ground.

Oscilloscope observations were made of the signal between the two remote grounds and between neutral and various points in the barn. An rf signal of about .10 V was observed and AC signals up to 4 V were also observed. The strongest AC signals appeared to be associated with the ground. These measurements indicated a high level of 60 Hz AC energy in the earth within the barn and all around the farm yard.

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

SPECIFIC CHANGES IN NEUTRAL GROUNDING

MITIGATION

These voltages appeared to be associated with the utility and therefore an isolation transformer was recommended. In 1984 an isolation transformer was installed which isolated the utility neutral from the farm neutral. A definite improvement was noted. The effects, however slowly returned to the herd but there were definite improvements that were maintained. Production well below genetic capability, peaking in production in first month of lactation, incidences of mastitis, high SCC and especially inability to breed successfully continue.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

The effects associated with the problem are those typically described as occurring under electrical fault conditions or stray voltage. Some of the effects were sudden outbreaks of mastitis which could not be successfully treated with antibiotics, high SCC, uneven or poor milk letdown, poor production, peaking in production in the first month after freshening, inability to breed, general health problems and various behavioral oddities. The individuals that were called in to investigate the problem finally suggested the possibility of stray voltage. Utility representatives measured the AC voltage between a remote ground and the farm neutral and discovered voltages that were sufficiently high to cause concern.

CONCLUSIONS

These levels were not affected by turning off the power on the farm.

A problem exists on this farm that is producing a significant impact on the dairy operation. The effects are those associated with electrical causes. No on farm faults could be identified. AC voltages that could shock the cows were not found and the cows showed no signs of being shocked in the barn. The cows, however, appeared to be under a great deal of stress in the barn and many did not want to enter their stalls. The farm operators were gentle and very careful so as not to place unnecessary stress on the animals when they did not want to enter their stalls. The factors that did concern me, however, was the indication of large AC energies in the earth which could produce AC fields and AC field gradients to which the cows would be exposed as they stand on the floor; and the continuously varying DC voltages which could indicate that there are sources of DC energy reaching the barn which are non galvanic. The origin and effects of these energies need to be investigated.

The only change that could be made on the farm that might be beneficial is moving the isolation transformer so as to increase the separation of the farm and utility neutrals (ground rods). When the two ground rods are separated by such a small distance, paths of greater conductivity could develop more quickly between the two rods that would decrease the value of the isolation transformer. In addition, consideration could be given to providing an opportunity for the cows to be off concrete while out of the barn. Because of the uncertainties of the ground conditions around the farm this change should be low cost, if done.

The solution to the problem will depend upon how quickly money is made available for research into cause and effect relationships. The questions that need to be answered are, "What form or forms of electromagnetism affects the cows, at what levels and what are the origins of the electromagnetism that is causing the effects."

CASE 122

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

Dog has seizures

Another dog died--reason unknown

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs

1st, 2nd, and 3rd person frequent headaches

1st, 2nd, and 3rd person frequent flu-like or cold symptoms
1st, 2nd, and 3rd person vision problems (e.g., blurred or heavy eyelids)
2nd and 3rd person problems with breathing
1st, 2nd, and 3rd person excessive fatigue
1st, 2nd, and 3rd person frequent irritability
1st, 2nd, and 3rd person often feeling under stress
1st, 2nd, and 3rd person weakness and pain in legs
1st and 2nd person forgetfulness
3rd person allergies
1st and 2nd person ears ringing
2nd and 3rd person pressure behind the eyes
2nd and 3rd person unexplained nausea
1st and 2nd person unexplained general feeling of not being well
3rd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
2nd person (female) problems with menstrual cycle
3rd person having an illness that medical professionals cannot diagnose

GENERAL INFORMATION

FARM CHARACTERISTICS

This farm has a metal facility with a pipeline milker. The stalls are comfort stalls. The barn equipment includes two silo unloaders, a barn cleaner, and a manure pump.

ELECTRICAL EFFECTS ON THE FARM

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure
Noisy telephone requiring frequent service calls or having false rings
Accelerated corrosion of well casings or other buried pipes
Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

Isolation transformer installed and all equipment and pipes regrounded in 1983. In March of 1992 he sold his dairy herd because of stray voltage. He is trying to work out a solution with his bank to be able to keep on farming

ELECTRICAL PROBLEMS ON THE FARM

The field representative from the dairy company noticed the stray voltage problem when he was checking on the farm's milking process.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The isolation transformer was installed in April of 1983, but it only improved conditions until Memorial Day weekend of 1983.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

MITIGATION

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

Symptoms observed since 1983.

3rd person regularly treated for rheumatoid arthritis and illnesses which medical professionals cannot diagnose

CASE 123

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Varied water consumption

Cows reluctant to enter barn and/or stalls

Cattle used to dance back and forth in stalls

Cattle used to kick milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs (at times cows will not stand near wood post, other times they lean against it, more often I see tops of heads and areas near ears pushed against cups and wood uprights.)

Want hilex water

Had a heifer 600 lbs. every time he got near her, she would try to ride him--was shown to vet, veterinary assistant, & neighbor, but could not be explained

Production

Uneven, incomplete and/or slow milkout

Poor milk production, began at 17,500 and dropped to 13,200

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts, rose to over 1,000,000

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills ("Why call they can't help")

Swollen glands/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Teat ends grew shut, when isolated

Drooling from nose and mouth

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Penicillin can cause abortions

Growing manes

Forehead hair down to eyes

Trouble drinking from water tank without car tires under them

Black hair coat turning brown or red

Trouble drinking from lake

Only one or two bulls have not turned ugly in 13 years, cows that were butchered, because of crippling, had meat more brown, then red, and bones were badly eaten up (osteoporosis)--bone centers were badly honey combed.

CALVES

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

Running with back legs, front legs locked solid--legs glowed

Fibrous tissue damage in calves udders, before they are off milk

Want hilex water

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

Cats rubbing against dog

Cat lost an entire tail in an accident and grew an entire new tail

Dog went from friendly to irritable and tries to bite

Dog tries to breed cats

All animals want Hilex water

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs

1st and 2nd person frequent headaches

1st person frequent flu-like or cold symptoms (until he started taking selenium and vitamins)

1st person vision problems (e.g., blurred or heavy eyelids)--also double vision, one above the other

1st person problems with breathing

1st person excessive fatigue

1st frequent irritability

1st person often feeling under stress

1st person weakness and pain in legs

1st person forgetfulness

1st person ears ringing

1st person pressure behind the eyes

1st person unexplained nausea

1st person unexplained general feeling of not being well

1st person rheumatoid arthritis

2nd person high incidence of non-malignant body tumors

2nd person (female) feeling bloated/retaining body fluids

2nd person having an illness that medical professionals cannot diagnose

Constant problem with tight neck and back muscles, causing migraine headache, have to use deep heat at base of skull and Tylenol to get rid of

Couldn't eat enough, until he started to take vitamins and selenium

Kids on the farm are quite often dark under eyes

Neighbors--

18 year old girl--brain tumor

her father died from leukemia

4 year old boy--brain tumor & number of joint replacements

man--heart attack & lots of back problems

boy--constant nasal drip

girl--nose bleeds at night

man--lung & bone cancer, 3 colon cancers

man--diabetes, emphysema, & heart problems

his wife has rare type of cancer

GENERAL INFORMATION

FARM CHARACTERISTICS

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)--and breeder sometimes kicks out
Unusually high rate of battery failure
Radio and TV set failure (non-lightning related)?
Not a shock, but a burning, stinging type feeling from water lines or faucets
Noisy telephone requiring frequent service calls or having false rings--leave it noisy
Accelerated corrosion of well casings or other buried pipes
Water in pails, etc. turn black
Water often looks like foam on top
Well pipes replaced every 4 1/2 years for holes
Galvanized drinking cup bottoms eaten out
Cup bolts eaten off
Metal often like welding carbon, than steel motor joints in milkhouse eaten out by what looks like foam

HISTORICAL BACKGROUND

MEASUREMENTS

1984, DC levels in the barn between grounds and cow contact points were in the range of 0.2 to 0.4 VDC. AC ranged between 0.01 and 0.04 V in the cow contact areas. These voltages were present whether or not electricity was being used on the farm. DC currents between the SN and stall would go up about 5% during milking. Measuring the AC between the grill of a fan with respect to ground would change from one day to the next. Barn appeared to have the characteristics that when conditions were especially adverse for the cows AC would build up to higher values on conductors in the barn when electrical equipment was turned on.

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

SPECIFIC CHANGES IN NEUTRAL GROUNDING

MITIGATION

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

Symptoms observed for 13 years
Human and animal symptoms occur within the same time frame

CONCLUSIONS

There are serious behavioral, production and health problems for cows on this farm.

These problems are characteristic of typical stray voltage farms.

The degree to which well casings, pipes, galvanized drinking cups, cup bolts, and motor joints are corroding on this farm is not normal. Sitting water should not turn black, nor should steel resemble welding carbon. The "foam" observed to accompany these problems is characteristic of the presence of current flow.

CASE 124

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stall
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia / anemia
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among un milked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in Chlamydia, pneumonia, and Bovine Viral Diarrhea (BVD)
Teeth found in feeders and feedbunk

CALVES

Calves needing extra attention to maintain survival rate
Calves unable to grow at normal rate while in barn
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull shaggy coats

HUMAN HEALTH

2nd person frequent headaches

1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
2nd person weakness and pain in legs
2nd person ears ringing
2nd person pressure behind the eyes
1st person unexplained general feeling of not being well
2nd person feeling bloated/retaining body fluids
2nd person problems with menstrual cycle

GENERAL INFORMATION

FARM CHARACTERISTICS

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Occasional shocks from water lines or faucets
Unexplained radio and TV interference
Noisy telephone requiring frequent service calls or having false rings
Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

The quality of the dairy operation requires an external cause for the effects. They have studied and examined every management practices to the effects on their herd. In their experiences with electrical changes, they have perceived connections with the effects on the cattle and electrical changes. The most significant changes in the behavior, health and production occurred when they built their new barn, when the new substation from which they receive their electricity was added, and when they were disconnected from a substation south of their town. All of these occurred about the same time -- 1978 was the year recalled. Although no immediate correlation can be found, the last three years have been especially difficult and the winter of 1990 and 1991 has been the worst. One possible connection with this past winter is the addition of a grounding field North of the farm.

MEASUREMENTS

Measurements on the dairy farm have provided some information. Between two ground rods about 100 meters apart there existed a voltage of 0.15 VAC on Dec. 1, 1990. The wave form was complex resulting from significant levels of harmonics. The DC voltage on the primary neutral was at 1.5 volts and oscillating. In addition to the harmonics, measurements in the barn also showed radio frequencies being picked up in the earth. In June the oscillation of the DC on the primary neutral was still present but the magnitude of the DC was much less (0.430 V). In June disconnecting the field ground grid north of the blue silo caused a change in both AC and DC in the earth North of the blue silo. In addition disconnecting that ground caused a decrease in the 60 Hz. current in the primary and secondary grounds at the transformer pole and meter posed, respectively.

ELECTRICAL PROBLEMS ON THE FARM

Electrical problems noted were the presence of the natural gas pipeline north of the farm and the open neutral buried electrical cable on three sides of the dairy farm.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Significant changes in behavior, health and production have occurred with the building of a new barn, when a new substation from which they receive their electricity was added, and when they were disconnected from a substation South of their town.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

There has been an addition of a grounding field North of the farm. The neutrals on this farm are separated.

MITIGATION

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

CONCLUSIONS

In attempting to assess the observation of the AC voltage changing from over a volt to millivolts between two points on the neutral, one would expect two possible causes. Either the AC in the neutral suddenly decreased or the voltage on one of the grounds significantly changed. Although the effect may be the same, the causes could be quite different. A significant current on the neutral could be produced if the 110 V loads were not balanced, for example. I would propose the possibility of a significant change in the AC on the field ground as being able to cause the same effect.

The specific suggestion is to begin with the additional grounding put in place North of the buildings. Try removing the connection to that ground and if additional grounding is required try placing ground rods south of the buildings. The primary ground rod carried a significant current into the earth at the transformer pole. The current can travel through the earth to the well and secondary grounding system. At least the primary grounding should be farther from the well and secondary grounding system. A better answer would be to attempt to maintain the current on the neutral wire back to the substation rather than permitting it to go through the earth.

CASE 125

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Poor hair coat
Inflamed sphincter valve (even among un milked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Excessive teeth found in feeders and feedbunk

CALVES

Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Dog has tumors
Dog arthritis

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs
1st and 2nd person frequent headaches
2nd person frequent flu-like or cold symptoms
1st and 2nd person vision problems (e.g. blurred or heavy eyelids)
1st person problems with breathing
1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st and 2nd person forgetfulness
3rd person allergies
1st and 2nd person ears ringing
2nd and 3rd person pressure behind the eyes
1st and 2nd person unexplained nausea
1st and 2nd person unexplained general feeling of not being well
2nd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
2nd person (female) problems with menstrual cycle
1st person having an illness that medical professionals cannot diagnose
1st person severe back problems that have gone away since the farm is totally isolated
2nd person (female) complete hysterectomy 13 years ago
1st and 2nd person cannot remember what they read
1st and 2nd person arthritis

GENERAL INFORMATION

FARM CHARACTERISTICS

This farm is located near a creek. There is a substation 11 miles away from the farm on the end of a 50 year old 7200 volt distribution line, which runs 2 miles away South of the farm. There is a natural gas pipeline 4 miles west of the farm, which lies between the farm and a substation. Currently they have 5 neighbors with stray voltage problems. They have a 12,00 watt FM radio station located 1/2 mile from these farms.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

noisy telephone requiring frequent service calls or having false rings

HISTORICAL BACKGROUND

This farm family has lived on this farm for 31 years. They have been struggling with cow problems since they built a new milking parlor 25 years ago. From 1982 until Dec. 1985 herd health improved, production went up 3,500# of milk per cow and they were milking 130 cows with no 3/4 cows and no mastitis. In December 1985 they were hit with the worst cases of udder problems they had ever seen. They lost 2 cows in 1 week to gangrene mastitis. The vet cultured the bacteria and they all tested sensitive to antibiotics, but treat the cow with them and they would not work. The cows immune system was incapable of protecting them. Finally in March of 1986 they discovered they had stray voltage and their utility isolated them. Their problems went away for 14 months and then their utility started grounding

their lines in their vicinity and the problems came back. They sold their cows 7 years ago, but still have problems with young cattle in certain parts of the farmstead.

MEASUREMENTS

Maximum primary neutral to earth voltage: 7.0 VAC
Minimum primary neutral to earth voltage: 2.5 VAC
Maximum secondary neutral to earth voltage: 0.5 VDC and 1.5 VAC
Minimum secondary neutral to earth voltage: 0.15 VDC and 0.02 VAC
Current on the primary grounding wires: 60 Ma AC
Current on the secondary grounding wires: 350 Ma AC (to milking parlor)

Cow contact voltages: 0.5 VDC between parlor metal and floor
0.7 VAC between parlor metal and floor

There is NO cow contact voltage high enough to cause a problem according to the power people (1 1/2 volts AC on secondary neutral).

There are 0.4 volt DC constant.

60 Hz magnetic fields are low throughout the farm--less than 0.1 mg, except in the home where magnetic fields ranged above 1.0 mg in sleeping areas. These fields did not appear to be associated with electrical wiring nor electrically operated equipment.

AC electric fields at the ground surface were less than 15 v/m throughout the central farm yard. North of the machine shed 50 v/m was not uncommon. At the second farm AC electric fields at the ground surface were as high as 300 v/m within the cattle pen.

A ferrite rod detector was used to demonstrate where there were concentrations of electromagnetic energy. The response demonstrated significant energies in a number areas on the farm and especially in the bed springs in the home. The radio station can actually be detected by the bed springs. Using an oscilloscope, measurements between the farm neutral and a remote ground indicated the presence of a radio carrier frequency signal with 1/2 the magnitude of the 60 Hz signal.

At the transmitter site significant electromagnetic energies engulfed the entire area. A strong electrical connection exists between the earth and the transmitting tower system. With the use of two different meters, 2000 amps were measured as being present in one of the guy wires. Measurements of 60 Hz magnetic and electric fields in the region reinforced the fact that large electric currents were present in all parts of the transmitter system.

There are large amounts of current flow through this farmstead when the ground is frozen or very dry.

ELECTRICAL PROBLEMS ON THE FARM

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Two changes in the immediate geographical area have correlated with increases in stray voltage symptoms. A radio transmission tower has been installed approximately one mile North of the farm as well as an addition of a new substation.

A four wire electrical system was installed with no noticeable effects.

Additional grounding was added with no alleviation of problems.

An isolation transformer was installed as well as separation of the grounding system from the neutral which resulted in an improvement in the livestock.

Reported changes in the health of the persons living on this farm with additional grounding on old wires and then the installation of a new line with a bigger wire, were that of tension, tiredness, memory loss, arthritis, constant burning of ankles, back problems. With total isolation 4 years ago these problems are very minimal.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

Primary neutral has been isolated.

Secondary neutral grounds reduced from 13 to 3.
Changes reported improvement in both animal and human health.

MITIGATION

An isolation transformer was installed 4 years ago, as well as separating ground system from the neutral.

OBSERVATIONS AND CONCLUSIONS

OBSERVATION

This farm is very well operated and maintained. The dairy operation had been very successful with few problems. During the recent number of years, however, conditions changed. The farm family noted a significant number of problems occurring in the dairy herd--the usually classified "stray voltage" effects. They also noted negative human health effects. About a year ago the dairy cattle were sold. The young stock were kept for future sale. These animals are pastured and fed at two different locations. The young stock have unexpected health problems and grow much more slowly than the average. An interesting observation: The effects on the cattle are different at the two locations and the level of effects changes becoming more severe at one location than at the other. The effects do not seem to be severe at both locations at the same time. A troubling observation is the detection of the nearby radio station through the significant concentration of energies in the bed springs in the home.

CONCLUSIONS

There is a severe behavioral and health problem for the persons and cattle on this farm.

These symptoms and effects are characteristic of a stray voltage farm.

60 Hz magnetic fields are low throughout the farm - less than 0.1 mg, except in the home where magnetic fields ranged above 1.0 mg in sleeping areas. These fields did not appear to be associated with electrical wiring nor electrically operated equipment.

At the transmitter sight significant electromagnetic energies engulfed the entire area. A strong electrical connection exists between the earth and the transmitting tower system. With the use of two different meters, 2000 amps were measured as being present in one of the guy wires. Measurements of 60 Hz magnetic and electric fields in the region reinforce the fact that large electric currents were present in all parts of the transmitter system. The radio signal which is detected by the bed springs is unacceptable. The radio carrier frequency, therefore, is introduced into the earth by the transmitting system. A radio station ought not impose that level of electromagnetic energy on any living organism and certainly not on humans. A thorough investigation must be made to determine how the radio signal reaches the bed springs and other areas of the house. A study of this case could also provide important information concerning health effects of electromagnetic energy.

CASE 130

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints

PETS

Cats sickly with tough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die

HUMAN HEALTH

1st, 2nd and 3rd person allergies
2nd person occurrence of heart related ailments

GENERAL INFORMATION

FARM CHARACTERISTICS

The electrical transmission line is 1/4 a mile away.

HISTORICAL INFORMATION

Has lived on the farm for 54 years
In the age group of 40's

MEASUREMENTS

Cow contact in the range of 1.0 VAC
The utility did a stray voltage check eight years ago and no problem was believed to exist.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Changes in electrical wiring have been made in the buildings. An electrical transmission line was recently added and recently a change in the natural gas or oil pipeline near the farm. These changes did not cause any clear change in effects.

CASE 131

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

MEASUREMENTS

Main switch was shut off, so all power coming in to the farm should be off. But the voltages in cow contact areas went up.

GENERAL INFORMATION

There are no electrical wiring recently been added and no recent changes in the natural gas or oil pipelines near the farm.

MITIGATION

Tingle voltage filter was installed in the fall of 1983, a little relief was experienced for about a year. After that the relief diminished. An EGS system was installed in December of 1986, at the cost of six thousand dollars and no results seen. Then in 1991 a neutral isolator was installed at the cost of six hundred and sixty-six dollars. DHIA RHA April 1991 was 16,000 pounds. Current DHIA RHA 20,500 pounds. A dramatic change in production, but still several health concerns for cattle. (breeding, swollen joints, and abscesses) So production could be better yet.

OBSERVATIONS & CONCLUSIONS

Virtually no voltage has been measured in cow contact area but as described by this farmer, the effects on this farm reveal what electricity is doing to the dairy industry.

CASE 132

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATORS

GENERAL INFORMATION

There is no electrical transmission line recently been added and there is a natural gas line one and a half miles north of the farm.

MEASUREMENTS

Maximum primary neutral to earth voltage is 9 VAC
Minimum primary neutral to earth voltage is 0.6 VAC
Maximum secondary neutral to earth voltage is 4.5 VAC
Minimum secondary neutral to earth voltage is 0 VAC
Measurements of current on the primary grounding wires is 4500 mA
Measurements of current on the secondary grounding wires is 740 mA

ELECTRICAL PROBLEMS ON THE FARM

Electric fence problems. The electricity was shunted to the ground, transferred through the barn, before returning to the fence. The return path went through the barn because it was a better conductor. Because the barn was a better conductor, than the neighbors barn became isolated. Seven other farms had to become isolated. All at which had an effect on animals and human health.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

The utilities removed the transformer and put primary neutral 385 ft from the dairy barn. The changes made in the electric utility system included deep grounds out at the road one half mile in each direction, and installing a neutral isolator.
Changes made on the secondary neutral is that they put in eleven ground rods in different location. When they did this it stopped the meter.
This utility company has installed deep grounds over 100 ft deep and proud of only 4 Ohm resistance.

OBSERVATIONS & CONCLUSIONS

The power company has in their file a warning to their maintenance lineman that they had in excess of 5 Amps in certain portions at their distribution line near the farm.

CASE 133

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Production

Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
Poor hair coat, constant lice problems
Stress rings on the hoofs (excessive growth)

CALVES

Not to many calves

PETS

Cats sickly with tough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person frequent headaches
1st person frequent flu-like or cold symptoms
1st person vision problems (e.g. blurred or heavy eyelids)
1st person problems with berating
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
1st person having an illness that medical professionals cannot diagnose
Back pain (may have been caused by car crash 3 years ago)

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unexplained fluctuations in electric bills

GENERAL INFORMATION

They have been living on the farm for 15 years.

In the age group of 20's.

There are no electrical transmission lines recently been added and no natural gas or oil pipelines near the farm.

MEASUREMENTS

6 Amps measured in the barn at the stalls. The utility is working on finding the source.

CASE 134

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

High somatic cell counts

CALVES

Calves having poor survival rate, summer was a problem

GENERAL INFORMATION

FARM CHARACTERISTICS

Has a natural gas or pipeline one mile away.

There are no electrical transmission lines and no recent changes in the natural gas or oil pipelines near the farm.

HISTORICAL BACKGROUND

In the age group of 30's

MEASUREMENTS

The voltage on the stall divider is 2.0 VAC.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The only electrical change was the installation of a grain drier three years ago.

CASE 135

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among un milked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
Excessive teeth found in feeders and feedbunk
Artheritis, cross front legs, get up like a dog

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore humps, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with tough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Dogs, same as the cats

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st and 2nd person frequent headaches
1st and 2nd person frequent flu-like or cold symptoms
1st person vision problems (e.g. blurred or heavy eyelids)
1st and 2nd person problems with berating
1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st and 2nd person forgetfulness
1st and 2nd person pressure behind the eyes
1st and 2nd person unexplained nausea
1st and 2nd person unexplained general feeling of not being well
2nd person high incidence of non-malignant body tumors
1st person (females) feeling bloated/retaining body fluids
1st person (females) problems with menstrual cycle
1st person occurrence of heart related ailments

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure
Increasing motor burnouts (bulk tank compressor motors)
Occasional shocks from water lines or faucets
Noisy telephone requiring frequent services calls or having false rings
Accelerated corrosion of well casings or other buried pipes
Unexplained fluctuations in electric bills

GENERAL INFORMATION

Has lived on the farm for 24 years.
Is in the age group of 60's and is a farmer.
A three and half week stray voltage trial found the utility to have a defective distribution system on our feeder line and were also found to be 100% negligent.

MEASUREMENTS

Maximum primary neutral to earth voltage is 30 AC.
Maximum secondary neutral to earth voltage is 30 AC.

ELECTRICAL PROBLEMS ON THE FARM

By 1987 the portion of the distribution line system built in the 30's was completely worn out and all six farms on the feeder line had to be isolated.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Until Jan 13, 1988 they had a dual service 3 wire 3 phase Delta Open Wye Grounded B Phase System served by a 4800 volt district system.

0.60 AC constantly and sometime higher after distribution line on a feeder line was rebuilt and completed in 1988. We saw both AC/DC on our voltmeter in the milking parlor.

Only for a short period after the new distribution line was rebuilt did the cows eat the bunk clean and then they appeared to eat in pockets leaving a lot of feed behind daily from the 4th quarter 1989 till our eviction.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

We believe by 1989 the EGS grounding bed was completely saturated and that between it and the mini ELF or counterpoise system it was playing ring around the rosy on the farm. The cattle would sniff the pipes when entering the milking parlor and could be right next to the water tank yet drink from a urine puddle or as another cow urinated.

MITIGATION

In 1987 they put in an EGS, along with a modified 4 wire system.

In 1988, went to a more pure 4 wired system when distribution line rebuilt. Completely rebuilt their distribution system on our feeder line. Finally after many, many years trimming trees on the feeder line. Before rebuilding the distribution system put in two regulators and a mini ELF system or counterpoise system.

Shortly after installing the EGS, our cattle began to hug the walls in the free stall barn. The buzzer went off constantly on the EGS. In 1989 we sent a letter to the Public Service Commission complaining about how scary it was to be in the milking parlor or free stall barn during a lighting storm. Cattle often jolted in parlor. When the distribution system was rebuilt they moved the three phase pole to our front yard and installed a 150KV transformer on the pole. They left the single phase pole across the road with a 50KV transformer. By the 4th quarter 1989 Joan's knees hurt so bad she slept in a recliner until eviction from farm in Feb of 1991. In 1990 no longer had earth worms in the yard and around buildings and the gophers and birds left. Sparrows only sat on far ends of free stall buildings in bad weather.

OBSERVATIONS & CONCLUSIONS

Cows hooves showed markings similar to a tree's circles showing X's and deep engraved lines. Reason this was noted is because haven't seen shiny hoofs on cattle since summer of 1986. Hooves always caked with dirt and noted lines etc. It was also common to find cows' teeth in bunk on a regular basis.

CASE 136

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
High somatic cell counts
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
Poor hair coat, constant lice problems
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore humps, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with tough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Dogs have distemper

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs
1st and 2nd person frequent headaches
1st and 2nd person frequent flu-like or cold symptoms
1st and 2nd person vision problems (e.g., blurred or heavy eyelids)

1st person problems with berating
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
2nd person weakness and pain in legs
1st and 2nd person forgetfulness
2nd person allergies
2nd person rheumatoid arthritis
2nd person high incidence of non-malignant body tumors
2nd person (females) feeling bloated/retaining body fluids
1st and 2nd person (females) problems with menstrual cycle

GENERAL INFORMATION

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

The farmer has lived on the farm for 14 years.
He is in the age group of the 50s.

MEASUREMENTS

Nothing was ever done. The utility company put their heads in the sand and pretended that no problem existed.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

They installed or repaired the neighbors farm grounds. There have been no changes on the grounding of equipment, the secondary neutral or the primary neutral on the farm.

MITIGATION

A neutral isolator was installed. Not all cows improved, but some cows did, as a result of the installation of the isolator. Some cows never recovered, and the best of the herd of 48 cows was sold this spring.

It takes a year for cows to recover from the shocks. The farmer finally had 23, but most never recovered and died. The farmer then decided to sell out.

CASE 137

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as, silent heats

Health

Swollen legs and joints

Inflamed sphincter valve (even among un milked heifers)

Heifers and cows have trouble getting up (legs seem numb)

CALVES

Calves with symptoms such as abscesses, unable to suck, rolls tongue

HUMAN HEALTH

1st person frequent headaches

1st and 2nd person often feeling under stress

1st and 2nd person weakness and pain in legs

1st and 2nd person forgetfulness

1st and 3rd person knee problems

1st person back problems

GENERAL INFORMATION

FARM CHARACTERISTICS

There is no electrical transmission line that has been recently added or no natural gas or oil pipelines near the farm.

There is no problem of electrical circuits on the neighboring farms.

HISTORICAL BACKGROUND

The farmer has lived in the farm for 32 years.
He is in the age group of the 30s.

MITIGATION

This farm has an isolator. No beneficial effects were noted.

MEASUREMENTS

The PN to remote ground excluded 2.5 VAC. The SN to remote ground was in the range of 0.05 to 0.1 VAC. Cow contact voltages were no more than 0.3 VAC.

CASE 138

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

MEASUREMENTS

Before the blocker was installed there was 2.5 volts in the barn. After installation it went down to less than 0.5 volts.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The changes in electrical wiring is that a blocker was installed in the main unit. There is no electrical transmission line recently been added and no recent changes in the natural gas or oil pipelines near the farm.

MITIGATION

After the blocker was put in mastitis problems decreased, production increased, nervousness in cattle disappeared, and there were no small shocks off barn walls.

When the blocker quit working about three years ago all the problems reappeared, so a different blocker was installed. At this time they were again questioning their blocker's work ability on the main line. REA was notified and they promised to check it.

CASE 139

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATORS

MITIGATION

Two years ago they had REA put up a “blocker” on the transformer pole. They also had a neutral isolator installed. The problems with the somatic cell count and problems with breeding continue to get worse.

CONCLUSION

Many farmers are having problems with stray voltage. But because of the mysterious nature of stray voltage it is not possible for individual farmers to have the financial ability to get things changed. We need someone to coordinate our individual efforts so that this problem is given the attention it deserves.

CASE 140

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Poor hair coat, constant lice problems

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore humps, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

Calves born alive, never get up and 3 days later die

PETS

Cats sickly with tough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

1st person forgetfulness

3rd person allergies

1st person having an illness that medical professionals cannot diagnose, back trouble and legs numb

GENERAL INFORMATION

FARM CHARACTERISTICS

There are no electrical transmission lines that have recently been added and no recent changes in the natural gas or oil pipelines near the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Noisy telephone requiring frequent service calls or having false rings, replaced phone
Accelerated corrosion of well casings or other buried pipes
Unexplained fluctuation in electric bills.

HISTORICAL BACKGROUND

Has lived on the farm for 29 years
In the age group of 20's and 40's.

MEASUREMENTS

Found 30 volts on the barn cleaner chains leaving the barn. Checked out and found URD cable had eroded and neutral was gone. Conductor had also been burned by something, voltage came up in the barn at the barn cleaner. They have yearly check ups. The power company comes out and installs meters and registers all readings. They have copies of all of this.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The three changes made in the electrical wiring are as follows: built new barn in 1990, installed additional ground rods all over farm and went to a four wired system.

The changes noticed were: definite herd improvements, somatic cell count drop and maintenance at a tolerable level. Also the barn cleaner has no voltage.

In the electrical equipment they added ground fences. The changes observed, is the increase to 1700 pounds production in three days.

By solving this problem, it has helped the well being of human health.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

The changes on the primary neutral and the secondary neutral are that they added ground rods.

MITIGATION

They installed TMR timer, forced feed cows minerals then cows become more conductive (electrical chargers pass through more easily). In order to improve cows it is recommended to take away all minerals for a while. This was done. Cows reacted less to voltage problems and then gradually they were put back on minerals and were monitored. These farmers feel cows are more tolerant if there aren't any voltage problems. (They have not observed any since they installed a four wire system, three years ago)

CASE 141

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions
High somatic cell counts, specific places in barn, some days and product is 80,000 - 200,000

Health

Multiple or recurring mastitis (not responding to treatment, 40 cows, 35 milking)
Swollen legs and joints
High veterinarian bills
Constant lice problems
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore humps, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair
Calves die often

PETS

Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Female dog comes into heat only in the spring, not in the fall

HUMAN HEALTH

1st person tingling or numbness in arms or legs
2nd person frequent headaches
1st, 2nd and 3rd person frequent flu-like or cold symptoms
2nd person vision problems (e.g. blurred or heavy eyelids)

1st, 2nd and 3rd person problems with berating
1st, 3rd and 4th person excessive fatigue
1st, 2nd and 3rd person often feeling under stress
1st, 3rd and 4th person weakness and pain in legs
1st and 3rd person forgetfulness
1st and 3rd person allergies
1st, 2nd, 3rd and 4th person ears ringing
2nd and 3rd person pressure behind the eyes
1st, 2nd and 3rd person unexplained nausea
2nd person (females) feeling bloated/retaining body fluids
2nd person (females) problems with menstrual cycle
1st person having an illness that medical professionals cannot diagnose, long infections
1st person occurrence of heart related ailments, heart attack but no EKG problems
1st person sugar level fluctuates

GENERAL INFORMATION

FARM CHARACTERISTICS

Has an electrical transmission line one mile away

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusually high rate of battery failure
Radio and TV set failure (non-lighting related, in barn 5 radios a year)
Increasing motor burnouts
Noisy telephone requiring frequent service calls or having false rings, neighbors too
Accelerated corrosion of well casings or other buried pipes and Pressure tank
Unexplained fluctuations in electric bills, \$230 - \$300 a month

HISTORICAL BACKGROUND

In the age group of 30's
Has lived on the farm for 6 years

MEASUREMENTS

The utility company has taken readings, but would not let us see the results.
Spikes in the barn reach 5.1 VAC.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The only change made in electrical wiring on the farm is that in 1989 a line was added to a silo. There are no recent changes in the natural gas or oil pipelines near the farm, but there is an electrical transmission line recently been installed for services to new homes.

MITIGATION

There is an equipotential plane in the barn and the house. It has no effect and the lights still dim.

OBSERVATIONS & CONCLUSIONS

Dad is diabetic, but he is not. When he is in the barn he has low sugar problems. The doctors say he has no health problems.

CASE 142

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts, was as high as 550, now down to 205
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Inability to maintain weight in cold weather
Inflamed sphincter valve (even among un milked heifers)
Stress rings on the hoofs (excessive growth)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves unable to grow at normal rate

PETS

Cats sickly with tough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die

HUMAN HEALTH

1st person frequent flu-like or cold symptoms
1st person excessive fatigue
1st person frequent irritability
1st and 2nd person often feeling under stress
1st person forgetfulness
2nd person neurological illness (e.g. Multiple Sclerosis)

GENERAL INFORMATION

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusually high rate of battery failure
Occasional shocks from water lines or faucets

HISTORICAL BACKGROUND

Has lived on the farm for 24 years
Is in the age group of 40's

ELECTRICAL CHANGES AND CORRELATING EFFECTS

On the farm the power company put up a new transformer. There are no electrical transmission lines and no recent changes in the natural gas or oil pipelines near the farm. Some work was done to the secondary neutral. There are no changes in the behavior of the cows. The farmer received shocks every time he touched the milkers. The farmer is uncertain of the procedure that the utility used to solve the problem. Apparently an isolator was installed.

MITIGATION

This farm is isolated.

CASE 143

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Health

Inflamed sphincter valve (even among un milked heifers)

Heifers and cows have trouble getting up (legs seem numb)

PETS

Cats sickly with tough, dull and shaggy coats

HUMAN HEALTH

1st person allergies

GENERAL INFORMATION

FARM CHARACTERISTICS

There are no electrical transmission lines that have recently been added and no recent changes in the natural gas or oil pipelines near the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

Has lived on the farm for 20 years

Is in the age group of 40's

MEASUREMENTS

Co-op took voltage and amp readings. They would be available upon request.

MITIGATION

Four years ago a neutral isolator was installed, the farm also has an equipotential plane in the barn. Changes were noticed in adding the isolator. In time it quieted the cattle down.

OBSERVATIONS & CONCLUSIONS

Cooperation between farmer, herd specialist and power supplier is necessary to solving problems.

CASE 144

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cattle dancing back and forth in stalls
Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
High somatic cell counts
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as diarrhea

HUMAN HEALTH

1st person excessive fatigue
1st person often feeling under stress
1st person weakness and pain in legs
1st person ears ringing
1st and 2nd person rheumatoid arthritis
1st person loss of short term memory
1st person lack of ability to think clearly

GENERAL INFORMATION

FARM CHARACTERISTICS

Has a natural gas or oil pipeline 200 yards away

HISTORICAL BACKGROUND

Has lived on the farm for 2 years
Is a farmer and in the age group of 20's

MEASUREMENTS

Maximum primary neutral to earth voltage is 1.0 VAC
Minimum primary neutral to earth voltage is 0.2 VAC
Maximum secondary neutral to earth voltage is 1.5 VAC
Minimum secondary neutral to earth voltage is 0.4 VAC
Water line to rear hoof, voltage 1.5 VAC
At cow contact points spikes were measured with an average voltage of 1 VAC

SPECIFIC CHANGES AND CORRELATING EFFECTS

The two changes in electrical wiring made on the farm were: some grounding and caps on bare wires. There are no electrical transmission lines been added and no recent changes in the natural gas or oil pipelines near the farm.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

The one change in the secondary neutral (main box), was added a ground. There was no noticeable changes because of a relative short period of time to make a judgment.

OBSERVATIONS AND CONCLUSIONS

There seems to be spots in the barn corresponding to the areas where the electrical problems were. Cattle close to these areas seemed to be affected more. Cattle under stress already were greatly affected. No changes produced a noticeable improvement.

CASE 145

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
High veterinarian bills
Tanish discharge under eyes, nostrils, and eyes

PETS

Cats sickly with tough, dull and shaggy coats

HUMAN HEALTH

1st person frequent headaches
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person unexplained general feeling of not being well

GENERAL INFORMATION

FARM CHARACTERISTICS

Has a natural gas or pipeline within a mile

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Increasing motor burnouts
Noisy telephone requiring frequent service calls or having false rings
Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

Has lived on the farm for 40 years
Is a farmer and in the age group of 40's

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The changes that were made in the electrical wiring are as follows: new control boxes were put in, rewired the barn twice, new triplex, new duplex, moved the transformer closer to the barn and put an isolator on. There are no electrical transmission lines that have recently been added and no recent changes in the natural gas or oil pipelines near the farm.

MITIGATION

By putting a neutral isolator on the farm it helped a lot when the problem was bad. It helped the cows settle down and the they were not quite as nervous. Also the SCC went down.

OBSERVATIONS & CONCLUSIONS

The farmer thinks the utility should replace all the power lines because from the time they were put up till now, the amount of power in the lines has increased by 100 times. If a farmer has a stray voltage problem the electric company should help to resolve the problem by performing the appropriate mitigation procedures.

CASE 146

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Synchronized tail switching

Production

High SCC

Breeding problems

Health

Milk fever

MEASUREMENTS

Even after isolation there was a voltage reading on neutral wire up to 0.4 volts.

MITIGATION

The utility installed an isolation transformer on this farm about two years ago. Before isolation every cow in a 46 cow stall barn would switch their tails at once as if on command. After being isolated this behavioral problem was not noticed any more.

For first year somatic cell counts were trending down but by the second year the SCC's were rising again and I was having more breeding problems in herd, we also had milk fever.

OBSERVATIONS AND CONCLUSIONS

The farmer stated: "I'm no electrical engineer and this whole problem boggles my mind. But I do believe it is wise to research better ways to deliver electrical energy to farms and residential customers and improved wiring at point of use."

CASE 147

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate

PETS

Cats sickly with tough, dull and shaggy coats

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st and 2nd person frequent headaches
1st person vision problems (e.g., blurred or heavy eyelids)
1st person excessive fatigue
1st person frequent irritability
1st person weakness and pain in legs
1st person ears ringing

GENERAL INFORMATION

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Radio and TV set failure (non-lightning related)
Increasing motor burnouts
Noisy telephone requiring frequent service calls or having false rings

HISTORICAL BACKGROUND

Has lived on the farm for 44 years
In the age group of 40's

MEASUREMENTS

Maximum primary neutral to earth voltage is 4 AC
Minimum primary neutral to earth voltage is 0.5 AC
Maximum secondary neutral to earth voltage is 3 AC
Minimum secondary neutral to earth voltage is 0.5 AC
Measurements of current on the primary grounding wires is 3 AC
Measurements of current on the secondary grounding wires is 0.5 AC
Cows in the milking parlor may contact voltages, of measurements between 2-4 AC

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The changes in electrical wiring made on the farm are as follows: the ground and neutral wires were separated. An EGS system was installed. Later the primary and secondary neutral were isolated from each other. The only change in the electric utility system is the a bigger transformer was installed. There are no electrical transmission lines that have recently been added and no recent changes in the natural gas or oil pipelines near the farm. None of these changes solved the problem. The only change that help was the installing of the EGS system but after one year it appeared to be no longer effective.

MITIGATION

This farm has a foul wire system and EGS, and an isolator. These provide no long term improvement.

OBSERVATIONS & CONCLUSIONS

The problem appears worse after a rain or in spring when the ground is wetter.

CASE 148

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Cow production peaking early and not holding

Health

Swollen legs and joints

High veterinarian bills

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

PETS

Cats sickly with tough, dull and shaggy coats

Small cats developed cancer in the legs, vet was surprised

HUMAN HEALTH

1st and 2nd person allergies

GENERAL INFORMATION

FARM CHARACTERISTICS

We have a lake within 100 feet of the barn therefore a lagoon is required.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Noisy telephone requiring frequent service calls or having false rings

Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

Has lived on the farm for 35 years

In the age group of 40's

MEASUREMENTS

The cow's stall 7.0 AC

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The change made in the electrical wiring was the installing of a new triplex overhead cable. There are no electrical transmission lines and no recent changes in the neutral gas or oil pipelines near the farm.

The University and the Utility Company checked out the stray voltage problem. The solution suggested was a neutral isolator.

MITIGATION

A neutral isolator was installed.

OBSERVATIONS

The stray voltage problem occurred for a period of time and was controlled by the isolator. Later the problems came back for a period of time.

CASE 149

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Varied water consumption

Cows reluctant to enter barn and/or stalls

Cattle dance back and forth in stalls

Cattle kick milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts, rose to over 1,000,000

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Swollen glands/anemia

Inability to maintain weight in cold weather

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

Tingling or numbness in arms or legs

Frequent and severe headaches

Frequent flu-like or cold symptoms

Vision problems (e.g., blurred or heavy eyelids)
Problems with breathing
Excessive fatigue
Frequent irritability
Often feeling under stress
Weakness and pain in legs
Loss of short term memory
Ears ringing
Pressure behind the eyes
Unexplained nausea
Unexplained general feeling of not being well
Rheumatoid arthritis
Having an illness that medical professionals cannot diagnose
One person blood in urine
One person bleeding through the skin

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm is well kept. Everything appears to be maintained. Machinery is limited because this farm family buys all of the feed for the cattle except for the grazing during the growing season. The barn is older, well maintained with tie stalls and a milk line.

Both the trailer and the farm receive their electricity from a single phase line along the county highway between 200 to 400 feet east of the buildings. Other factors include an N/S transmission line about two miles East and a wetland area with large body of standing water to the West of the farm. The farm also has a high water table.

ELECTRICAL EFFECTS ON FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure
Radio and TV set failure (non-lightning related)?
Not a shock, but a burning, stinging type feeling from water lines or faucets
Noisy telephone requiring frequent service calls or having false rings
Accelerated corrosion of well casings or other buried pipe

HISTORICAL BACKGROUND

This farm family has a long history of experience with dairy cows and horses. After losing one dairy operation to a stray voltage problem and a number of years in the horse business, two years ago this farm family began a dairy and horse operation on his present farm. Apparently his first farm had more serious stray voltage problems than the second. At the previous farm both the farmer and his mother spoke of light traveling up and down electric utility poles as well as between poles on the ground. Utility personnel were often able to correct the problem by making changes in the system. The thought is that these events occurred if the wires were too close together or insulators dirty.

MEASUREMENTS

At the meter pole between the guy wire anchor connected to the primary neutral and the deep well by the house there was 1.0 volt. Only the home was using electricity at the time. Between the primary neutral and earth, the range was from 1.0 to 1.5 VAC and 0.25 VDC. The voltage between the secondary neutral and the ground rod at the meter pole ranged between 0.1 and 0.2 VAC. With the primary neutral disconnected from the ground rod but connected through the guy wires, the voltage measurement between the two neutrals varied radically at times from 0.1 to 0.9 VAC. Turning on a 220 V load increased the primary neutral to earth voltage from 0.9 to 1.3 VAC. The secondary neutral also showed a change but more difficult to quantify because of changes in other electrical use. Disconnecting the electricity to the farm reduced the secondary neutral to earth current by about 60%. Using a battery powered oscilloscope the signal observed for secondary neutral to ground had a triangular shape and also a square shape varying randomly. The primary neutral to earth signal was a somewhat distorted sine wave.

All measurements in the barn between the secondary neutral and various conductors in the barn produced voltages below 0.2 VAC even during milking. When equipment was turned on in the barn that operated on 220 volts, the secondary neutral to stall divider voltage nearly doubled. In addition the 60 Hz magnetic fields increased in some areas of the barn when the 220 volt load was on. The signal on the oscilloscope continually changed from a triangular to a more structured shape. Included also in the signal was a radio frequency voltage about 5 mVAC p-p and frequent spikes. From the shape of the curves, harmonics were clearly present. No attempt was made to assess the significance of the direct currents in the barn. They were noted to be present and less than 0.1 volt between the neutral and stall divider. The DC magnetic fields in the barn were variable in the range of 0.56 to 0.62 gauss in the barn. The field was always higher near the floor than at 1 meter above. At one location and at one time period there was a significant variation in the field but I could not be sure if it were the meter. The 60 Hz magnetic fields ranged between 0.1 and 0.2 mg in the barn to 2.5 mg under the distribution line along the highway. The field was vertical indicating a current in the horizontal plane. The currents necessary to produce those fields would be both in the wires of the distribution line and in the earth. At one location higher 60 Hz fields were near the floor than at one meter. Such a measurement would suggest that current in the earth is contributing to the 60 Hz magnetic field readings. Around the bulk tank, the 60 Hz magnetic field was up to 0.25 at a distance from the floor equivalent to the center of the bulk tank. AC electric fields ranged between 0.5 and 1 v/m throughout the barn except near electrically connected equipment. No electrical equipment was in operation in the barn at the time.

ELECTRICAL PROBLEMS ON THE FARM

Copper pipes in the barn and copper wiring in places had turned black.

For no apparent reason, when either lights or equipment were turned on anywhere on the farm, AC voltages could be found on all conductors. Currents could be measured on wires that were not even connected to a ground. This occurred whether 240 or 120 V equipment was turned on.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The farm family has discovered that connecting their water system to the well near their home causes such a negative health impact on both livestock and people that they must not only not use the well for water but must have their electrical system completely disconnected from the well. As a consequence of this observed effect, the farm family spent nearly \$2000 in extensive water testing that revealed only that the water had a high iron content.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

Whenever additional ground rods are connected to the farm neutral, the health effects also significantly increase.

Any connection of the electrical neutral wires to the new well near the home makes conditions intolerable for both animal and humans. As a consequence this well cannot be used. Grounding has a negative impact on the health of both human and animals.

MITIGATION

The farm is isolated but the mother's home is not. The guy wires are connecting the neutral to the earth on the farm, however.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

The cattle are adversely affected by increased mineral or salt intake. Minerals including salt could affect the electrical conductivity of the cows. High sugar content and low protein are also important for maintaining health and production. The greater the quantity of milk in the bulk tank the more serious the problems are for the cows.

The entire family has had health problems that appear to be related to the time on the farm. When in school, away from the farm for work or other reason their health is much better. None of the illness's can be diagnosed. One family member finds that when he takes a load of horses to Texas by truck he feels much better. It takes until reaching approximately the Alabama border before he really begins to feel good. Shortly after reaching the farm, the same adverse health conditions return.

On this farm, one family member had blood in his urine almost continuously when on the farm as well as bleeding through the skin on other parts of the body when conditions were especially bad in the barn. Curiously, there is no unusual bleeding for this person when they are off the farm.

When cows were given oxytocin with a small needle they would bleed for 24 hours.

At times when the mother is washing dishes at the sink in her home, the hairs on her arms stand up similarly to being connected to an electrostatic generator.

Family members state that when they stand up after putting the milker on the cow, they become dizzy and light headed.

When rain is actually falling on the farm the cows are much better. Likewise when there is no precipitation their problems are worse. Wet ground conditions may or may not increase the problems.

Cattle will not drink from the water tanks, even though plastic, when the plastic water hose is in the tank. They will drink only from plastic tanks and with no water hose in the water. Water for the farm is obtained from a shallow well some distance from the buildings.

Cattle and horses usually graze as far West in the pasture as they can get and rarely are on the East side. The grass is left in clumps around the pasture. The animals will only eat the grass down at particular locations.

CONCLUSIONS

Significant and severe human health problems have occurred and are occurring for this farm family which are perceived by them and others as being extremely unusual and as being caused by electricity. The effects are associated with living on their farm and especially working in the dairy barn. The specific effects are similar to those experienced by many other dairy operators throughout the country that appear to correlated with EM conditions and electrical changes.

The effects in the dairy herd and among other livestock on the farm are, of course, of great economic concern. These effects are severe with heavy loss of production and livestock. Animals are not able to survive if confined to the barn for any length of time. The farm family found it impossible to keep cattle alive in the barn through the winter season. During the winter of 1992-93, they had to dry up their dairy herd and leave the cows outside in order for them to survive the winter. Such a condition clearly means that a problem exists in the barn and all of the evidence points to electrical causes.

In measurements on this farm, 60 Hz AC magnetic field levels indicate significant currents in the earth in the region of the farm. In addition, with the electricity turned off on the farm these magnetic field levels persist and there are currents on all conductors connecting the earth to the secondary neutral including water line and propane gas line. When the farm's electrical system is off there are still currents and voltages in the barn that are certainly caused in part by the currents in the earth.

CASE 150

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATORS

CATTLE

Behavior

Cattle kicking milkers off

Cattle pressing their noses against stall, pipes, water cups or cement curb

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

Breeding problems such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment) -- Heifers freshen with mastitis and antibiotic treatment does not help.

Swollen legs and joints

High somatic cell count

Stress rings on hoofs (excessive growth)

CALVES

Unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair.

Some calves seem to be born with colds.

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

Dog gets a lot of tumors

Last dog died of cancer

HUMAN HEALTH

1st and 3rd person tingling or numbness in arms or legs

1st, 2nd and 3rd person frequent headaches

1st and 2nd person frequent flu-like or cold symptoms

3rd person problems with breathing

1st and 3rd person excessive fatigue

1st and 3rd frequent irritability

1st and 3rd person weakness and pain in legs

3rd person forgetfulness

3rd person allergies

1st person ears ringing
3rd person unexplained nausea

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a 400 KV DC transmission line 400 meters South of their home. There are other major electrical transmission lines 900 meters from the home.

ELECTRICAL EFFECTS ON FARM

Noted were:

Increasing motor burnouts

HISTORICAL BACKGROUND

This farm family has lived on this particular farm for 35 years. Two years ago the farm site was isolated. This stopped some of the dairy cattle uneasiness. However, working in the fields where the farmer has no cob protection he experiences headaches, nausea, and irritability. Depending on which way the wind blows the cattle that are pastured will try to escape the ions. For the farmer it feels like he has rolled in a barley bin because he itches so much.

MEASUREMENTS

The electric utility personnel came out to the farm to monitor the 400 KV DC line and check for stray voltage. The farm was then isolated.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The problems described were observed to begin when the transmission line was energized.

MITIGATION

An isolation device was installed.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

There has been an unusually high number of deaths in the neighborhood due to heart attacks and cancer. One neighbor - sudden heart attack - age 70, another neighbor - sudden heart attack - 63, sudden heart attack - 52, cancer - 65, cancer - 65, cancer - 70, sudden heart attack - 72, brain tumor - 55, heart attack - 50, cancer - 70, cancer - 42. One other neighbor woman has cancer and her spouse has a loss of memory and does not feel well. Doctors can find nothing wrong. They live 2 miles South of the line. Fixed symptoms in cows and deaths among neighbors have been observed since shortly after the line was energized.

CONCLUSIONS

There are serious behavioral, production and health problems for cows on this farm.

The symptoms and effects are characteristic of stray voltage farms.

) There are significant human health problems of concern in this area that demand attention and cooperation from the utilities and research professionals.

CASE 151

ANIMAL AND HUMAN WELL-BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Extreme nervousness

Cows had to be forced to enter parlor

Production

Breeding problems--low conception rates

Poor milk production

Health

Severe mastitis

High SCC

GENERAL INFORMATION

FARM CHARACTERISTICS

The facility is wood, block, and metal. The milker is a pipeline milker. The stalls are Herringbone and the barn equipment is chore boy

HISTORICAL BACKGROUND

Father and sons formed a partnership on January 1, 1976, to operate a 1000 acre grain and dairy farm with about 100 cows and raising all dairy heifers. This included one farm with its existing dairy, and two other farms.

In the late 70's the dairy operation was improved by the new dairy and field equipment. In 1991 the Farm Credit people forced the sale of all cattle, equipment and land. None of the family is now connected to farming any more.

In 1979 they installed a large Mix Mill feed system and the dealer encouraged them to have three phase electric service installed. The Power Company installed a three phase "high leg" system, with two hot wires and a hot ground wire instead of the standard "Delta" system with three hot wires and a true ground.

In 1980 the milk house was remodeled and new equipment installed. Things went well at first, but then in early 1983 mastitis became severe. The purchased cows had very good production records, but in a few months of calving they would have severe mastitis. The dairy field person was concerned about getting high somatic cell count down. Within six months of calving 18 of these heifers had been sent to slaughter.

The vet was not of much help in finding the cause. Stray voltage was suspected. An engineer checked all electric equipment. He could find nothing wrong. The milking equipment dealer assured the farm family that their equipment was working properly. When they were fed silage, the cows demonstrated behavioral effects. It was proved that the "High leg" system was 97% of the problem.

MEASUREMENTS

Measurements revealed 58 V on spikes between neutral and ground, and steady state voltage up to 10 VAC.

ELECTRICAL CHANGES AND CORRELATING EFFECT

An EGS System was installed. The animal behavior, health production and breeding improved considerably. No changes were notice in human health or electrical equipment. Unfortunately, the improvement was not sufficient to overcome the losses.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

One day the EGS was accidentally unplugged while milking, the cows responded negatively.

MITIGATION

The EGS was installed and the difference was amazing. The cows' behavior was much better in the parlor and soon they would come in without being driven in. New cases of mastitis dropped and production increased. In a longer time frame, conception rates had improved.

OBSERVATIONS AND CONCLUSIONS

Stray voltage problem was mainly responsible for the loss of the dairy operation.

CASE 152

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cattle kicked at farmer
Cattle kicked off milkers

*these events brought the problem to the attention of the farmer

Production

Low production

GENERAL INFORMATION

FARM CHARACTERISTICS

The facility is wood and they use a pipeline milker. The stalls are steel.

MEASUREMENTS

6-9 VAC were measured between the power company neutral and the earth.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The electric utility separated the neutrals. There are no recent changes in the natural gas or the oil pipelines near the farm.

Before isolation what was especially noticeable were shocks in the shower and sink in the house. In the barn the farmer experienced shocks from the bulk tank and the milk pipeline. Conditions were considerably improved after isolation. No longer were people shocked in the house or barn.

MITIGATION

This farm is isolated.

CASE 153

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.
Lots of tail swishing

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters

HUMAN HEALTH

1st person tingling or numbness in arms or legs
2nd and 3rd person frequent headaches
3rd person frequent flu-like or cold symptoms
2nd person problems with breathing
1st person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st person weakness and pain in legs
1st and 2nd person forgetfulness
1st and 3rd person allergies
2nd person unexplained nausea
2nd person (female) feeling bloated/retaining body fluids
3rd person having an illness that medical professionals cannot diagnose

GENERAL INFORMATION

FARM CHARACTERISTICS

This farm is in a wet area with high water table and numerous lakes in the area. The dairy barn is a stall type.

ELECTRICAL EFFECTS ON FARM

Noted were:

- Incandescent lamp failures (sometimes in groups, explosions)
- Unusually high rate of battery failure
- Radio and TV set failure (non-lightning related)
- Increasing motor burnouts
- Noisy telephone requiring frequent service calls or having false rings
- Accelerated corrosion of well casings or other buried pipes
- Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

The farmer is in his 40's and has lived on the farm for 19 years. For 12 of those years he has been dealing with a stray voltage problem. As other farmers have done, this farmer did an analysis of his management and could find nothing that could cause the problems experienced in his dairy herd. When stray voltage was brought to his attention, he had measurements made. These measurements indicated the utility neutral was at a sufficiently high voltage to cause problems in the barn. The farm was isolated and initially there was a significant improvement in the behavior, health and production of the dairy herd. After a brief period, the adverse conditions returned and the farmer tried other mitigation methods. The final installation was the EGS. This system apparently has some benefits, but the problems in the dairy herd and the human health problems persist.

MEASUREMENTS

With the EGS the secondary neutral to earth voltages and cow contact voltages are below 0.5 VAC. When connections are made between components in the barn, however, currents ranging in the 10 to 100 mA AC are not uncommon. In addition, there are DC voltages present at cow contact points. These are in the range of 0.2 and 0.4 VDC.

MITIGATION

This farm is isolated and has an EGS. Neither has solved the stray voltage problem.

CASE 154

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore humps, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

Calves shake and vet can't figure it out

PETS

Cats sickly with tough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

1st person tingling or numbness in arms or legs

1st and 2nd person vision problems (e.g., blurred or heavy eyelids)

2nd person problems with berating

1st and 2nd person excessive fatigue

1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st person ears ringing
2nd person feeling bloated/retaining body fluids
1st person having an illness that medical professionals cannot diagnose
2nd person occurrence of heart related ailments
1st person myocardiopathy (irregular heart beat)
1st person irritability
1st person disintegrating disc in vertebrae

GENERAL INFORMATION

FARM CHARACTERISTICS

Is a 90 cow Ty stall dairy barn about 3 miles from a nuclear substation.
Has an electrical transmission line 3 miles away
Has a natural gas or pipeline 2 miles away

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure
Radio and TV set failure (non-lighting related)
Increasing motor burnout's
Occasional shocks from water lines or faucets (better since wired farm)
Accelerated corrosion of well casings or other buried pipes and water lines
Unexplained fluctuations in electric bills
The phone gets noisy and static all the time.

HISTORICAL BACKGROUND

The family has lived on the farm for 30 years and is now in the age group of 60's. This farm family has been engaged in organic agriculture for a number of years to avoid the potential effects from chemical exposure.

MEASUREMENTS

Many measurements have been made on this farm. The AC magnetic fields were in the range of 0.1 to 0.2 mg away from the power lines and throughout the farm area. These measurements and electric field measurements revealed the presence of AC in the earth and greater in some areas than others. These observations were made with all electricity of f on the farm. After the mitigation procedures the cow contact voltages were consistently low in the range of 0.1 to 0.2 VAC. Before any electrical changes had been made and when stray voltage was first investigated the cow contact voltages were in the range of 0.3 to 0.4 VAC. The source was identified to be the utility neutral. At times spikes have also been measured on the grounding system.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

One year ago the electrical wiring was changed on the farm to a four wire system. The changes made in the electric utility system is the SWAT team made the power company change the service in front of the

farm. These changes had only momentary beneficial effects and the overall improvement has been quite small.

During the years of stray voltage problems on this farm many electrical changes have been made. Three years ago the utility company changed the electrical transmission line along the highway. The farmers believe their electricity was rerouted from different distribution line/substation. At this point, milk production rose 500 pounds and continued to rise. Six months later milk production began to drop. Two months later herd health was very poor. Production then continued to bounce up and down but steadily declined. Five years ago a second oil pipeline was put in. Today the problems are as serious as before the changes were made. There was, however, a change in the livestock, health or production and human health immediately after the new line started operation. In fact whenever electrical changes were made, effects were noted in the livestock. The stray voltage problem, however, has been ongoing since 1981.

MITIGATION

Ten years ago the utility put in an isolation device. Several electrical engineers told them at that point, however, that they were not truly isolated. They were still hooked to the ground system on the wires, and electricity was still feeding back through the ground.

Two years ago they made them put in a new isolator. The changes observed were positive but only temporary.

OBSERVATIONS

For this farm the problems were the worst in winter when it was very cold.

Even though this farm has had every expert available to attempt to solve the problems on the farm, the effects for both humans and animals have at best remained stable but serious and more likely deteriorated over the years of struggling with the problem.

CASE 155

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production (went from 16,000 to 9,000 in seven years)

Breedback difficulties

Cow production peaking early and not holding - the cows seemed to be in very good health when they came fresh, started milking 90 pounds a day, one month later down to 40 pounds a day, and in another month down to 30 pounds a day

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Poor hair coat, constant lice problems

HOGS - Little pigs look great up to three weeks then after that they go backwards. It seems that the sows go down on their milk, and they do not lose much weight. In fact, they have not once had one thin sow yet.

FARM CHARACTERISTICS

The farmers have 60 brood sows in their barn. They are selling 40 pound feeder pigs.

This is a wood and metal facility with a pipeline milker. The stalls are stanchion. The barn equipment includes a barn cleaner and silo unloader.

HISTORICAL BACKGROUND

The farmer has lived on the farm for 36 years and is in the 50's age group. There certainly is a problem. The farmer was forced to quit the farming operation.

MEASUREMENTS

Before installation of the isolator the AC current was very low. After installation it was almost 0.

MITIGATION

This farm is isolated. Even though the cow contact voltage was nearly 0 after the installation of the isolator, there were no improvements in the behavior and health/production of the livestock.

CASE 156

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among unmilked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
Excessive teeth found in feeders and feedbunk

CALVES

Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

HOGS

Similar problems to cattle
Mastitis
Unmanageable sows
Sows eat young
Small litters

PETS

Leukemia in cats

Cats sickly with rough, dull and shaggy coats

Cats leave farm and die

Dog has stiff joints

Dog becomes skittish at different points of property

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs

1st person frequent headaches

1st and 2nd person vision problems (e.g., blurred or heavy eyelids)

1st and 2nd person excessive fatigue

1st and 2nd person frequent irritability

1st person often feeling under stress

1st and 2nd person weakness and pain in legs

1st person forgetfulness

1st and 2nd person allergies

2nd person neurological illness (e.g., Multiple Sclerosis)

2nd person pressure behind the eyes

1st and 2nd person unexplained general feeling of not being well

1st and 2nd person rheumatoid arthritis

1st person having an illness that medical professionals cannot diagnose

1st person occurrence of heart related ailments

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm is a parlor type and contains 20 milk units. It is located in an area with a high water table. The farm is surrounded with wet lands and open water is prevalent in the area.

HISTORICAL INFORMATION

In the early to mid 1980's, the farmers' dairy herd began to demonstrate a variety of abnormalities, including a substantial decrease in milk production and a substantial increase in the incidence of mastitis.

The above problems with their dairy herd caused the farmers to spend a substantial amount of money for veterinarian services, specialized feed and nutrients and equipment while, at the same time, they suffered a loss of revenue as a result of decreased milk production.

In an attempt to resolve these problems, the farmers hired various professionals and consultants to perform extensive testing of their facilities and dairy herd, and they supplied their cattle with superior feed and nutrients; yet, the problems mentioned above persisted.

The farmers were unaware of the cause of their dairy herd problems until August 1992, when a service representative of their dairy performed an inspection, causing him to conclude that they had a problem with stray voltage; and he then suggested they involve their utility company. A utility company representative, upon inspection and testing, confirmed that their farm was experiencing stray voltage probably from off-farm sources.

Within two weeks, a utility work crew arrived at the farmers' farm and performed work upon the electrical supply lines located on the farmers' property. The utility company's representatives then advised the farmers that their work would serve to solve all of their stray voltage problems

In December 1992, and again in February 1993, a utility work crew again visited the farmers' premises, where it performed work on the farm. On both occasions, the farmers received no advance notice of, or explanation for, the work to be performed at their premises.

In mid-March, 1993, the farmers' dairy herd began to act "jumpy and nervous" in the milking parlor. Suspecting stray voltage was again present, the farmers promptly reported it to the utility company, which responded by dispatching its representative to reinstall a volt meter. On March 19, 23, and 26, 1993, the farmers personally observed meter reading in excess of three volts in his milking parlor.

MEASUREMENTS

AC magnetic fields were in the range of 0.05 and 0.1 mg throughout the farm yard. With the power turned on, the voltage between the PN and SN was 5.6 VAC and the short circuit current was 2700 mA AC. With the power turned off the voltage between the PN and the SN was 1.4 VAC and the short circuit current was 600 mA. With the SN and PN connected the N-E voltage was 1.4 volts with the farm power on. Under these same conditions 160 mA AC was going into the earth of the primary grounding wire. Cow contact voltages in the parlor were below 0.5 VAC. Before isolation cow contact voltages had been measured to be in the range of 1.5 to 2.0 VAC. A measurement of current in the parlor was made by connecting a Fluke 87 between a metal contact on one side of the parlor to a metal contact on the other side of the parlor. This was a short circuit current measurement between two points that are connected through the metal in the barn. With the power on and the isolator operating, there was 1.4 mA AC and 2.4 mA DC between these two points. When a jumper wire was attached between the PN and SN and the power still on the current was 14 mA AC and 2.6 mA DC. With the power turned off and the jumper still connected the current was 5.6 mA AC and with the isolator operating, the short circuit current was 0.00 mA AC. This same measurement was made with the power on, the isolator on the farm operating, and a jumper placed on between the PN and SN of a home across the road from the farm. Under these conditions the current was 1.6 mA AC. When the jumper was removed, the current decreased to 1.4 mA AC. Between the PN and SN at this second place, there was a voltage of 1.0 VAC and a short circuit current of 360 mA AC. There was no known electrical connection between the two places.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The electric utility has made many changes in the area of the farm and has not provided any information to the farmer. Two changes that were observable were the moving the farm primary ground to a dryer location that was farther away from the secondary grounding and the isolating and adding new grounding at the place across the road. Changes were noted in the dairy herd but because of all the changes occurring it was not possible to determine the correlations.

MITIGATION

This farm has been isolated as well as the pole across the road. The improvement in the dairy herd has been significant since the isolation of the dairy farm. The problem is still not totally solved. The cows are not comfortable, continue to have foot problems, act as if they were especially stupid and do not like to be touched.

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

Female member of the family experienced the beginning of MS while she was doing the milking.

Rain enhances problems.

At this time the dairy herd is primarily heifers.

CONCLUSIONS

The problems on this farm have decreased significantly after isolation but a number of effects can still be observed in the dairy herd. Milk production is still not where the farmer believes it should be.

CASE 157

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Poor hair coat, constant lice problems

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

HUMAN HEALTH

1st person tingling or numbness in arms or legs

1st person frequent headaches

1st person frequent flu-like or cold symptoms

1st person excessive fatigue

1st person frequent irritability

1st person often feeling under stress

1st person weakness and pain in legs

1st person forgetfulness

1st person pressure behind the eyes

1st person unexplained general feeling of not being well

GENERAL INFORMATION

FARM CHARACTERISTICS

This farm is located in a region with a high water table, and a transmission line is located approximately 1000 meters from the farm.

ELECTRICAL EFFECTS ON FARM

Noted were:

- Incandescent lamp failures (sometimes in groups, explosions)
- Occasional shocks from water lines or faucets
- Noisy telephone requiring frequent service calls or having false rings
- Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

The farmer has lived on the farm for 36 years and is in the 30's age group. He has explored every possible cause for problems on his farm. He has had experts in a number of areas of farm management and has utilized electrical experts to attempt to solve his stray voltage problem. On July 25, 1990, the farmer sold the dairy herd and after November 1990 no animals have been on the farm except for a dog and some cats. The farmer does not want animals to suffer from stray voltage again on his farm.

MEASUREMENTS

After isolation the cow contact voltages were well below the 0.5 VAC considered capable of causing stray voltage effects.

MITIGATION

This farm is isolated. Although beneficial results were noted for the dairy herd after isolation, these benefits did not continue. The farm problems have continued.

OBSERVATIONS

Symptoms noted for 9 years.

Human and animal symptoms occur within the same time frame.

CASE 158

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption (will drink snow melt or mud puddles)
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts (very erratic)
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
Inability to maintain weight in cold weather (at all times)
Poor hair coat, constant lice problems
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
Feed goes through undigested

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs
3rd person frequent headaches
2nd person frequent flu-like or cold symptoms
1st and 2nd person problems with breathing
1st, 2nd, and 3rd person excessive fatigue
2nd person frequent irritability

1st, 2nd, and 3rd person often feeling under stress
1st and 3rd person weakness and pain in legs
1st, 2nd, and 3rd person forgetfulness
1st, 2nd, and 3rd person allergies
1st person ears ringing (tickle)
1st, 2nd, and 3rd person unexplained nausea
1st, 2nd, and 3rd person unexplained general feeling of not being well
2nd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
Reproductive system affected

GENERAL INFORMATION

ELECTRICAL EFFECT ON FARM

Occasional shocks from water lines or faucets

HISTORICAL BACKGROUND

Has lived on the farm for 20 years and is in the 50's age group.

MEASUREMENTS

Maximum primary neutral to earth voltage: 13 VAC
Minimum primary neutral to earth voltage: 2.5 VAC
Measurements of current on the primary grounding wires: 115 ma AC
Measurements of current on the secondary grounding wire: 15 ma AC
Cow contact voltages and contact points between which measurements were made: 0 AC at all point in barn with equipotential plane

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Replaced wires that showed current on outside. Immediate positive response that lasted a month then gradually disappeared. Built new barn with equipotential plane.

SPECIFIC CHANGES IN NEUTRAL GROUNDING

Checked connections and grounds. Isolated neutrals.

OBSERVATIONS

Symptoms observed for 216 months. Human and animal symptoms occur within the same time frame.

CASE 159

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Heifers and cows have trouble getting up (legs seem numb)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs
1st person frequent headaches
2nd person vision problems (e.g., blurred or heavy eyelids)
1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st and 2nd person forgetfulness
1st and 2nd person ears ringing
1st and 2nd person unexplained nausea
1st and 2nd person unexplained general feeling of not being well
2nd person (female) feeling bloated/retaining body fluids
2nd person (female) problems with menstrual cycle

HISTORY OF EVENTS ON THE NELSON FARM 1991-1995

12/7/91	On Veterinary advice, the herd of cows was moved to a farm 6 1/2 miles away from the Nelson farm. Prior to the move, the herd of 30 cows consumed an average of only 13 gallons of water per day, and the herd average milk production dropped from 71 to 42 pounds.
1/27/92	Testing done on farm by utility. Primary Neutral Voltage during the morning milking was 3.13 Vac, by noon it had decreased to 1.72 Vac, by 3:00 pm it was only 0.72 Vac.
3/25/92	Installation of an isolating transformer, by an electrician, at the barn service panel.
4/1/92	Primary neutral grounding disconnected at driveway.
6/15/92	Substation serving farm was shutdown, 2 cows aborted overnight, Renee 5 months pregnant starts having labor pains and is rushed to the hospital.
7/10/92	Primary neutral grounding reconnected at driveway.
7/27/92	Multi-disciplinary meeting held at farm.
8/19/92	Primary neutral grounding disconnected at driveway.
9/2/92	Isolator installed at barn service panel burned out.
9/4/92	Four wire system installed at the barn service panel.
12/7/92	Utility grounding reconnected at driveway, tests done by utility.
12/9/92	Isolation device installed.
12/13/92	Primary neutral grounding disconnected at driveway.
1/1/93	Primary neutral grounds at driveway are still disconnected.
2/5/93	Governmental agency visits farm.
2/8/93	Utility company shut down substation 3 1/2 miles north of farm.
3/15/93	Utility grounds connected at driveway.
3/19/93	Utility moves transformer and a spark gap isolator is installed.
3/26/93	Disconnection of grounds at driveway.
5/26/93	Connection of grounds at driveway. Tests done on farm.
6/1/93	Disconnection of grounds at driveway.

9/14/93	Cow unexplainably bleeds to death in barn.
9/22/93	Cow in stall across from one that bleed to death dies from heart attack.
9/29/93	2 heifers electrocuted in shed with main switch pulled and no electricity on.
10/93	Installation of Vulcan trap.
12/93	Utility company working on capacitor.
1/15/94	Disconnection of grounds on county road running past farm.
2/18/94	Utility installs new jumper wires from neutral to ground for 2 mile span surrounding farm.
2/22/94	Utility reconnects grounds along county road.
2/24/94	Utility installs numerous 48 feet deep ground rods along county road.
2/25/94	2 additional 48 foot ground rods are installed at one location on county road.
2/28/94	Disconnection of grounds along county road.
3/29/94	Connection of grounds along county road.
3/30/94	Disconnection of grounds along county road.
5/15/94	Fishing opener.
6/1/94	Grounded irrigators start usage.
8/19/94	Grounds connected at driveway.
8/26/94	Transformer grounds disconnected.
12/22/94	Utility company calls and requests tests next day, tests were not taken.
1/13/95	Electrical fire, trailer house fire 1 mile south of farm.
1/26/95	Hooked Vulcan trap to primary neutral at 4:30pm, 1.5 Amps current.
1/31/95	Disconnected Vulcan trap and primary neutral 5:30am.

1993

Milk Production
on the Lonnie Nelson Farm

1994

Date	Total Milk Produced	# of Cows Milked	Pounds/Cow/Day	Rolling Herd Average	Av. Lbs/Day for the Month
1/2/93	2,953.00	30.00	49.22	15,011.08	
1/4/93	2,971.00	31.00	47.92	14,615.40	
1/6/93	2,934.00	31.00	47.32	14,433.39	
1/8/93	2,924.00	31.00	47.16	14,384.19	
1/10/93	3,034.00	31.00	48.94	14,925.32	
1/12/93	3,096.00	31.00	49.94	15,230.32	
1/14/93	3,020.00	31.00	48.71	14,856.45	
1/16/93	3,268.00	32.00	51.06	15,574.06	
1/18/93	3,431.00	33.00	51.98	15,855.38	
1/20/93	3,540.00	33.00	53.64	16,359.09	
1/22/93	3,359.00	33.00	50.89	15,522.65	
1/24/93	3,522.00	33.00	53.36	16,275.91	
1/26/93	3,555.00	33.00	53.86	16,428.41	
1/28/93	3,487.00	33.00	52.83	16,114.17	
1/30/93	3,364.00	33.00	50.97	15,545.76	
2/1/93	3,282.00	33.00	49.73	15,166.82	
2/3/93	3,249.00	33.00	49.23	15,014.32	
2/5/93	3,315.00	33.00	50.23	15,319.32	
2/7/93	2,730.00	33.00	41.36	12,615.91	
2/9/93	3,681.00	33.00	55.77	17,010.68	
2/11/93	3,315.00	33.00	50.23	15,319.32	
2/13/93	3,333.00	33.00	50.50	15,402.50	
2/15/93	3,364.00	33.00	50.97	15,545.76	
2/17/93	3,368.00	33.00	51.03	15,564.24	
2/19/93	3,306.00	33.00	50.09	15,277.73	
2/21/93	3,483.00	33.00	52.77	16,095.68	
2/23/93	3,440.00	33.00	52.12	15,896.97	
2/25/93	3,364.00	33.00	50.97	15,545.76	
2/27/93	3,354.00	33.00	50.82	15,499.55	
3/1/93	3,301.00	33.00	50.02	15,254.62	
3/3/93	3,354.00	33.00	50.82	15,499.55	
3/5/93	3,350.00	30.00	55.83	17,029.17	
3/7/93	3,268.00	29.00	56.34	17,185.17	
3/9/93	3,258.00	29.00	56.17	17,132.59	
3/11/93	3,297.00	29.00	56.84	17,337.67	
3/13/93	3,239.00	29.00	55.84	17,032.67	
3/15/93	3,192.00	29.00	55.03	16,785.52	
3/17/93	3,125.00	28.00	55.80	17,020.09	
3/20/93	4,637.00	28.00	55.20	16,836.73	
3/22/93	3,024.00	28.00	54.00	16,470.00	
3/24/93	3,196.00	29.00	55.10	16,806.55	
3/26/93	3,101.00	29.00	53.47	16,306.98	
3/28/93	3,124.00	29.00	53.86	16,427.93	
3/30/93	3,034.00	29.00	52.31	15,954.66	
4/1/93	2,867.00	26.00	55.13	16,816.06	
4/3/93	2,890.00	26.00	55.58	16,950.96	
4/5/93	2,819.00	26.00	54.21	16,534.52	
4/7/93	2,666.00	24.00	55.54	16,940.21	
4/9/93	2,757.00	24.00	57.44	17,518.44	

Milk Production
on the Lonnie Nelson Farm

4/11/93	2,852.00	24.00	59.42	18,122.08
4/13/93	2,862.00	24.00	59.63	18,185.63
4/15/93	2,881.00	24.00	60.02	18,306.35
4/17/93	2,857.00	24.00	59.52	18,153.85
4/19/93	2,881.00	24.00	60.02	18,306.35
4/21/93	2,857.00	24.00	59.52	18,153.85
4/23/93	2,934.00	24.00	61.13	18,643.13
4/25/93	2,809.00	24.00	58.52	17,848.85
4/27/93	2,924.00	24.00	60.92	18,579.58
4/29/93	2,980.00	27.00	55.19	16,831.48
5/3/93	3,067.00	27.00	49.47	15,087.66
5/5/93	3,148.00	27.00	50.77	15,486.13
5/7/93	3,165.00	27.00	51.05	15,569.76
5/9/93	3,058.00	27.00	49.32	15,043.39
5/11/93	3,258.00	29.00	50.91	15,526.41
5/13/93	3,459.00	30.00	52.41	15,984.77
5/15/93	3,622.00	30.00	54.88	16,738.03
5/17/93	3,550.00	30.00	53.79	16,405.30
5/19/93	3,469.00	32.00	52.56	16,030.98
5/21/93	3,536.00	32.00	53.58	16,340.61
5/23/93	3,550.00	31.00	53.79	16,405.30
5/25/93	3,617.00	31.00	54.80	16,714.92
5/27/93	3,900.00	32.00	59.09	18,022.73
5/29/93	3,952.00	33.00	59.88	18,263.03
5/31/93	4,308.00	36.00	65.27	19,908.18
6/2/93	4,331.00	36.00	60.15	18,346.60
6/4/93	4,417.00	35.00	63.10	19,245.50
6/6/93	4,433.00	36.00	61.57	18,778.68
6/8/93	4,284.00	35.00	61.20	18,666.00
6/10/93	4,312.00	35.00	61.60	18,788.00
6/12/93	4,244.00	35.00	60.63	18,491.71
6/14/93	4,694.00	34.00	69.03	21,053.97
6/16/93	4,191.00	35.00	59.87	18,260.79
6/18/93	4,495.00	36.00	62.43	19,041.32
6/20/93	4,503.00	36.00	62.54	19,075.21
6/22/93	4,551.00	35.00	65.01	19,829.36
6/24/93	4,585.00	35.00	65.50	19,977.50
6/26/93	4,585.00	36.00	63.68	19,422.57
6/28/93	4,698.00	36.00	65.25	19,901.25
6/30/93	4,691.00	36.00	65.15	19,871.60
7/1/93	2,279.00	36.00	63.31	19,308.19
7/3/93	4,622.00	36.00	64.19	19,579.31
7/5/93	4,468.00	36.00	62.06	18,926.94
7/7/93	4,445.00	37.00	60.07	18,320.61
7/9/93	4,382.00	36.00	60.86	18,562.64
7/11/93	4,300.00	36.00	59.72	18,215.28
7/13/93	4,280.00	36.00	59.44	18,130.56
7/15/93	4,339.00	36.00	60.26	18,380.49
7/17/93	4,347.00	37.00	58.74	17,916.69
7/19/93	4,292.00	36.00	59.61	18,181.39
7/21/93	4,089.00	34.00	60.13	18,340.37

1993

Milk Production
on the Lonnie Nelson Farm

1994

7/23/93	4,171.00	34.00	61.34	18,708.16
7/25/93	4,068.00	34.00	59.82	18,246.18
7/27/93	4,105.00	35.00	58.64	17,886.07
7/29/93	4,214.00	35.00	60.20	18,361.00
7/31/93	4,097.00	34.00	60.25	18,376.25
8/2/93	4,012.00	34.00	59.00	17,995.00
8/4/93	4,154.00	34.00	61.09	18,631.91
8/6/93	4,261.00	36.00	59.18	18,050.07
8/8/93	4,363.00	36.00	60.60	18,482.15
8/10/93	4,300.00	37.00	58.11	17,722.97
8/12/93	4,433.00	38.00	58.33	17,790.33
8/14/93	4,347.00	38.00	57.20	17,445.20
8/16/93	4,400.00	38.00	57.89	17,657.89
8/18/93	4,292.00	38.00	56.47	17,224.47
8/20/93	4,273.00	38.00	56.22	17,148.22
8/22/93	4,300.00	38.00	56.58	17,256.58
8/24/93	4,244.00	38.00	55.84	17,031.84
8/26/93	4,335.00	38.00	57.04	17,397.04
8/28/93	4,261.00	38.00	56.07	17,100.07
8/30/93	4,300.00	39.00	55.13	16,814.10
9/1/93	4,269.00	40.00	53.36	16,275.56
9/3/93	4,323.00	40.00	54.04	16,481.44
9/5/93	4,402.00	40.00	55.03	16,782.63
9/7/93	4,544.00	40.00	56.80	17,324.00
9/9/93	4,533.00	40.00	56.66	17,282.06
9/11/93	4,526.00	39.00	58.03	17,697.82
9/13/93	4,402.00	39.00	56.44	17,212.95
9/15/93	4,236.00	38.00	55.74	16,999.74
9/17/93	4,277.00	38.00	56.28	17,164.28
9/19/93	4,323.00	38.00	56.88	17,348.88
9/21/93	4,277.00	38.00	56.28	17,164.28
9/23/93	4,269.00	38.00	56.17	17,132.17
9/25/93	4,231.00	38.00	55.67	16,979.67
9/27/93	4,503.00	40.00	56.29	17,167.69
9/29/93	4,386.00	40.00	54.83	16,721.63
10/1/93	4,480.00	40.00	56.00	17,080.00
10/3/93	4,227.00	38.00	55.62	16,963.62
10/5/93	4,158.00	38.00	54.71	16,686.71
10/7/93	4,003.00	36.00	55.60	16,957.15
10/9/93	4,120.00	37.00	55.68	16,981.08
10/11/93	4,105.00	37.00	55.47	16,919.26
10/13/93	4,187.00	39.00	53.68	16,372.24
10/15/93	4,116.00	39.00	52.77	16,094.62
10/17/93	4,059.00	39.00	52.04	15,871.73
10/19/93	4,021.00	39.00	51.55	15,723.14
10/21/93	4,145.00	40.00	51.81	15,802.81
10/23/93	4,064.00	40.00	50.80	15,494.00
10/25/93	4,089.00	40.00	51.11	15,589.31
10/27/93	4,112.00	40.00	51.40	15,677.00
10/29/93	3,968.00	39.00	50.87	15,515.90
10/31/93	4,120.00	38.00	54.21	16,534.21

1993

Milk Production
on the Lonnie Nelson Farm

1994

11/2/93	4,101.00	39.00	52.58	16,035.96	
11/4/93	4,162.00	39.00	53.36	16,274.49	
11/6/93	4,016.00	38.00	52.84	16,116.84	
11/8/93	4,021.00	38.00	52.91	16,136.91	
11/10/93	4,046.00	38.00	53.24	16,237.24	
11/12/93	3,995.00	38.00	52.57	16,032.57	
11/14/93	3,995.00	37.00	52.88	16,127.91	
11/16/93	3,913.00	36.00	53.51	16,321.74	
11/18/93	3,853.00	35.00	54.86	16,731.43	
11/20/93	3,840.00	36.00	52.50	16,012.50	
11/22/93	3,780.00	36.00	53.75	16,393.75	
11/24/93	3,870.00	36.00	53.15	16,211.60	
11/26/93	3,827.00	36.00	51.90	15,830.35	
11/28/93	3,737.00	36.00	53.21	16,228.54	
11/30/93	3,831.00	36.00	53.21	16,228.54	
12/2/93	3,861.00	35.00	55.16	16,822.93	
12/4/93	3,879.00	35.00	55.41	16,901.36	
12/6/93	3,763.00	35.00	53.76	16,395.93	
12/8/93	3,732.00	35.00	53.31	16,260.86	
12/10/93	3,720.00	35.00	53.14	16,208.57	
12/12/93	3,775.00	35.00	53.93	16,448.21	
12/14/93	3,586.00	35.00	51.23	15,624.71	
12/16/93	3,724.00	36.00	51.72	15,775.28	
12/18/93	3,698.00	36.00	51.36	15,665.14	
12/20/93	3,737.00	36.00	51.90	15,830.35	
12/22/93	3,689.00	36.00	51.24	15,627.01	
12/24/93	3,672.00	36.00	51.00	15,555.00	
12/26/93	3,586.00	36.00	49.81	15,190.69	
12/28/93	3,715.00	37.00	50.20	15,311.82	
12/30/93	3,728.00	37.00	50.38	15,365.41	52.00
1/1/94	3,681.00	37.00	49.74	15,171.69	
1/3/94	3,655.00	36.00	50.76	15,482.99	
1/5/94	3,569.00	35.00	50.99	15,550.64	
1/7/94	3,626.00	36.00	50.36	15,360.14	
1/9/94	3,698.00	36.00	51.36	15,665.14	
1/11/94	3,694.00	36.00	51.31	15,648.19	
1/13/94	3,758.00	36.00	52.19	15,919.31	
1/15/94	3,823.00	36.00	53.10	16,194.65	
1/17/94	3,689.00	35.00	52.70	16,073.50	
1/19/94	3,672.00	35.00	52.46	15,999.43	
1/21/94	3,728.00	35.00	53.26	16,243.43	
1/23/94	3,853.00	35.00	55.04	16,788.07	
1/25/94	3,767.00	34.00	55.40	16,896.10	
1/27/94	3,771.00	34.00	55.46	16,914.04	
1/29/94	3,763.00	34.00	55.34	16,878.16	
1/31/94	3,763.00	35.00	53.76	16,395.93	56.00
2/2/94	3,672.00	34.00	54.00	16,470.00	
2/4/94	3,595.00	34.00	52.87	16,124.63	
2/6/94	3,459.00	32.00	54.05	16,484.30	
2/8/94	3,297.00	31.00	53.18	16,219.11	
2/10/94	3,101.00	30.00	51.68	15,763.42	

1993

Milk Production
on the Lonnie Nelson Farm

1994

2/12/94	3,378.00	32.00	52.78	16,098.28	
2/14/94	3,397.00	32.00	53.08	16,188.83	
2/16/94	3,333.00	32.00	52.08	15,883.83	
2/18/94	3,513.00	33.00	53.23	16,234.32	
2/20/94	3,586.00	33.00	54.33	16,571.67	
2/22/94	3,631.00	34.00	53.40	16,286.10	
2/24/94	3,608.00	34.00	53.06	16,182.94	
2/26/94	3,564.00	34.00	52.41	15,985.59	
2/28/94	3,595.00	34.00	52.87	16,124.63	54.00
3/2/94	3,578.00	34.00	52.62	16,048.38	
3/4/94	3,410.00	34.00	50.15	15,294.85	
3/6/94	3,378.00	31.00	54.48	16,617.58	
3/8/94	3,459.00	32.00	54.05	16,484.30	
3/10/94	3,513.00	32.00	54.89	16,741.64	
3/12/94	3,431.00	31.00	55.34	16,878.31	
3/14/94	3,401.00	31.00	54.85	16,730.73	
3/16/94	3,315.00	31.00	53.47	16,307.66	
3/18/94	3,423.00	31.00	55.21	16,838.95	
3/20/94	3,364.00	31.00	54.26	16,548.71	
3/22/94	3,454.00	31.00	55.71	16,991.45	
3/24/94	3,387.00	32.00	52.92	16,141.17	
3/26/94	3,392.00	32.00	53.00	16,165.00	
3/28/94	3,341.00	31.00	53.89	16,435.56	
3/30/94	3,364.00	31.00	54.26	16,548.71	56.00
4/1/94	3,401.00	31.00	54.85	16,730.73	
4/3/94	3,478.00	31.00	56.10	17,109.52	
4/5/94	3,595.00	32.00	56.17	17,132.42	
4/7/94	3,622.00	32.00	56.59	17,261.09	
4/9/94	3,849.00	33.00	58.32	17,787.05	
4/11/94	3,866.00	33.00	58.58	17,865.61	
4/13/94	3,990.00	34.00	58.68	17,896.32	
4/15/94	3,926.00	34.00	57.74	17,609.26	
4/17/94	3,814.00	33.00	57.79	17,625.30	
4/19/94	3,930.00	33.00	59.55	18,161.36	
4/21/94	4,089.00	34.00	60.13	18,340.37	
4/23/94	4,137.00	34.00	60.84	18,555.66	
4/25/94	4,038.00	34.00	59.38	18,111.62	
4/27/94	4,171.00	35.00	59.59	18,173.64	
4/29/94	4,277.00	36.00	59.40	18,117.85	54.00
5/1/94	4,366.00	36.00	60.64	18,494.86	
5/3/94	4,456.00	36.00	61.89	18,876.11	
5/5/94	4,421.00	36.00	61.40	18,727.85	
5/7/94	4,507.00	36.00	62.60	19,092.15	
5/9/94	4,476.00	36.00	62.17	18,960.83	
5/11/94	4,476.00	36.00	62.17	18,960.83	
5/13/94	4,562.00	36.00	63.36	19,325.14	
5/15/94	4,492.00	36.00	62.39	19,028.61	
5/17/94	4,683.00	36.00	65.04	19,837.71	
5/19/94	4,652.00	36.00	64.61	19,706.39	
5/21/94	4,637.00	36.00	64.40	19,642.85	
5/23/94	4,562.00	36.00	63.36	19,325.14	

Milk Production
on the Lonnie Nelson Farm

5/25/94	4,433.00	36.00	61.57	18,778.68	
5/27/94	4,652.00	36.00	64.61	19,706.39	
5/29/94	4,687.00	36.00	65.10	19,854.65	
5/31/94	4,819.00	36.00	66.93	20,413.82	63.00
6/2/94	4,370.00	36.00	60.69	18,511.81	
6/4/94	4,476.00	36.00	62.17	18,960.83	
6/6/94	4,671.00	36.00	64.88	19,786.88	
6/8/94	4,660.00	36.00	64.72	19,740.28	
6/10/94	4,630.00	36.00	64.31	19,613.19	
6/12/94	4,712.00	36.00	65.44	19,960.56	
6/14/94	4,551.00	36.00	63.21	19,278.54	
6/16/94	4,578.00	36.00	63.58	19,392.92	
6/18/94	4,449.00	36.00	61.79	18,846.46	
6/20/94	4,394.00	36.00	61.03	18,613.47	
6/22/94	4,374.00	36.00	60.75	18,528.75	
6/24/94	4,615.00	36.00	64.10	19,549.65	
6/26/94	4,574.00	36.00	63.53	19,375.97	
6/30/94	9,347.00	36.00	64.91	19,797.47	66.00
7/2/94	4,759.00	41.00	58.04	17,701.16	
7/4/94	4,633.00	41.00	56.50	17,232.50	
7/6/94	4,644.00	41.00	56.63	17,273.41	
7/8/94	4,519.00	42.00	53.80	16,408.27	
7/10/94	4,578.00	42.00	54.50	16,622.50	
7/12/94	4,601.00	42.00	54.77	16,706.01	
7/14/94	4,519.00	42.00	53.80	16,408.27	
7/16/94	4,402.00	42.00	52.40	15,983.45	
7/18/94	4,402.00	43.00	51.19	15,611.74	
7/20/94	4,566.00	43.00	53.09	16,193.37	
7/22/94	4,316.00	44.00	49.05	14,958.86	
7/24/94	4,816.00	44.00	54.73	16,691.82	
7/26/94	4,581.00	44.00	52.06	15,877.33	
7/28/94	4,691.00	44.00	53.31	16,258.58	
7/30/94	4,796.00	44.00	54.50	16,622.50	56.00
8/1/94	4,562.00	43.00	53.05	16,179.19	
8/3/94	4,626.00	43.00	53.79	16,406.16	
8/5/94	4,394.00	43.00	51.09	15,583.37	
8/7/94	4,331.00	43.00	50.36	15,359.94	
8/9/94	4,370.00	43.00	50.81	15,498.26	
8/11/94	4,425.00	43.00	51.45	15,693.31	
8/13/94	4,378.00	43.00	50.91	15,526.63	
8/15/94	4,355.00	43.00	50.64	15,445.06	
8/17/94	4,331.00	43.00	50.36	15,359.94	
8/19/94	4,128.00	43.00	48.00	14,640.00	
8/21/94	4,108.00	43.00	47.77	14,569.07	
8/23/94	4,198.00	43.00	48.81	14,888.26	
8/25/94	4,120.00	43.00	47.91	14,611.63	
8/27/94	4,003.00	43.00	46.55	14,196.69	
8/29/94	3,917.00	43.00	45.55	13,891.69	
8/31/94	4,137.00	43.00	48.10	14,671.92	
9/2/94	3,917.00	43.00	45.55	13,891.69	
9/4/94	3,986.00	43.00	46.35	14,136.40	

9/6/94	3,935.00	43.00	45.76	13,955.52	
9/8/94	3,909.00	43.00	45.45	13,863.31	
9/10/94	3,857.00	43.00	44.85	13,678.90	
9/12/94	3,685.00	43.00	42.85	13,068.90	
9/14/94	3,595.00	43.00	41.80	12,749.71	
9/16/94	3,650.00	43.00	42.44	12,944.77	
9/18/94	3,645.00	43.00	42.38	12,927.03	
9/20/94	3,754.00	43.00	43.65	13,313.60	
9/22/94	3,750.00	43.00	43.60	13,299.42	
9/24/94	3,926.00	44.00	44.61	13,607.16	
9/26/94	3,823.00	44.00	43.44	13,250.17	
9/28/94	3,745.00	44.00	42.56	12,979.83	
9/30/94	3,715.00	44.00	42.22	12,875.85	49.00
10/2/94	3,745.00	44.00	42.56	12,979.83	
10/4/94	3,681.00	42.00	43.82	13,365.54	
10/6/94	3,775.00	44.00	42.90	13,083.81	
10/8/94	3,827.00	44.00	43.49	13,264.03	
10/10/94	3,823.00	44.00	43.44	13,250.17	
10/12/94	3,810.00	44.00	43.30	13,205.11	
10/14/94	3,788.00	44.00	43.05	13,128.86	
10/16/94	3,917.00	44.00	44.51	13,575.97	
10/18/94	3,702.00	44.00	42.07	12,830.80	
10/20/94	3,645.00	44.00	41.42	12,633.24	
10/22/94	3,655.00	41.00	44.57	13,594.82	
10/24/94	3,459.00	41.00	42.18	12,865.79	
10/26/94	3,341.00	39.00	42.83	13,064.17	
10/28/94	3,315.00	39.00	42.50	12,962.50	
10/30/94	3,368.00	39.00	43.18	13,169.74	45.00
11/1/94	3,410.00	38.00	44.87	13,684.87	
11/3/94	3,414.00	38.00	44.92	13,700.92	
11/5/94	3,306.00	38.00	43.50	13,267.50	
11/7/94	3,182.00	37.00	43.00	13,115.00	
11/9/94	3,125.00	35.00	44.64	13,616.07	
11/11/94	3,129.00	35.00	44.70	13,633.50	
11/13/94	3,106.00	35.00	44.37	13,533.29	
11/15/94	3,350.00	36.00	46.53	14,190.97	
11/17/94	3,096.00	35.00	44.23	13,489.71	
11/19/94	3,058.00	35.00	43.69	13,324.14	
11/21/94	3,086.00	35.00	44.09	13,446.14	
11/23/94	3,101.00	36.00	43.07	13,136.18	
11/25/94	3,509.00	39.00	44.99	13,721.09	
11/27/94	3,473.00	39.00	44.53	13,580.32	
11/29/94	3,545.00	39.00	45.45	13,861.86	
12/1/94	3,545.00	39.00	45.45	13,861.86	
12/3/94	3,492.00	39.00	44.77	13,654.62	
12/5/94	3,505.00	39.00	44.94	13,705.45	
12/7/94	3,469.00	39.00	44.47	13,564.68	
12/9/94	3,431.00	39.00	43.99	13,416.09	
12/11/94	3,320.00	36.00	46.11	14,063.89	
12/13/94	3,427.00	36.00	47.60	14,517.15	
12/15/94	3,459.00	36.00	48.04	14,652.71	

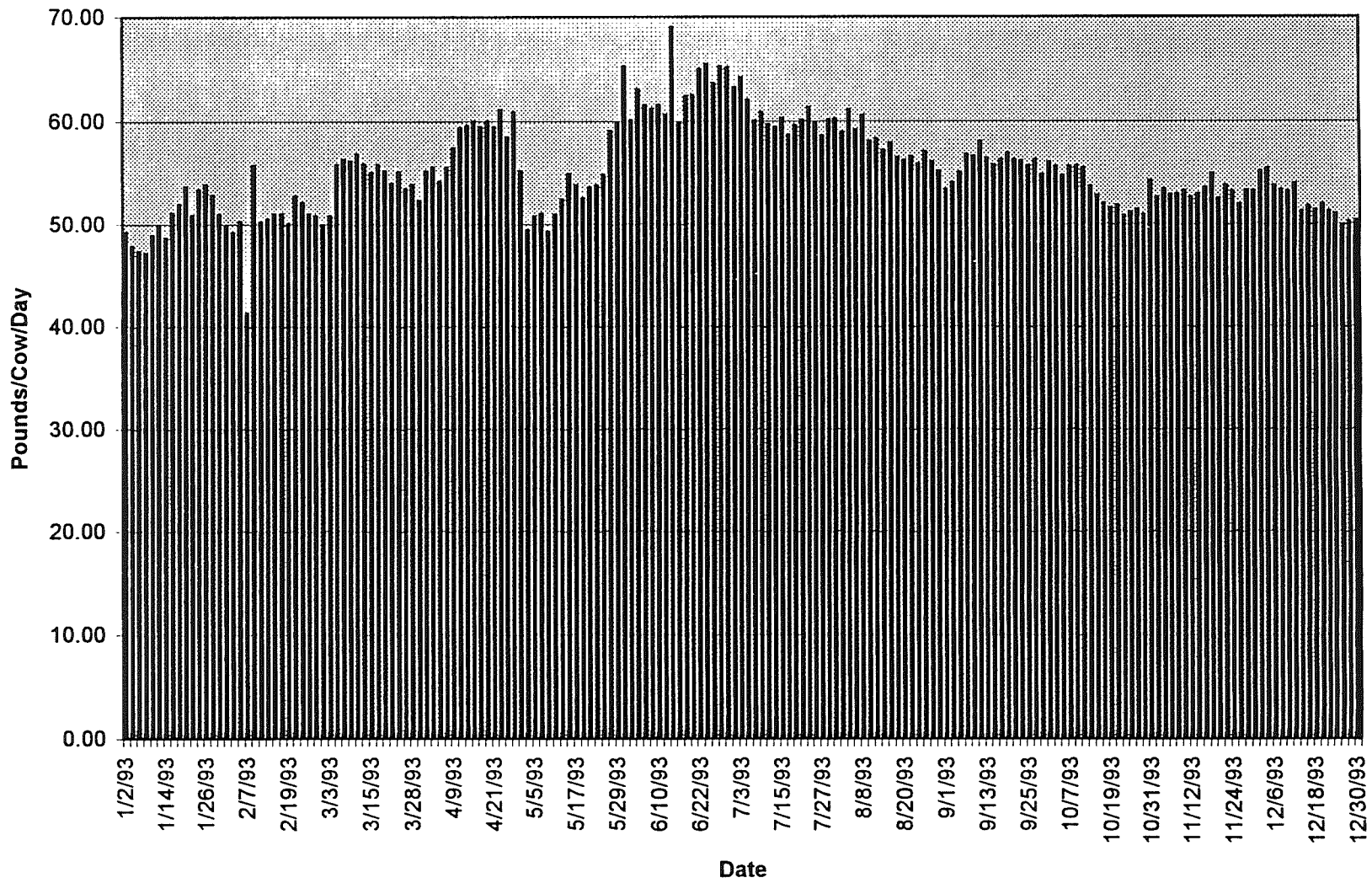
1993

Milk Production
on the Lonnie Nelson Farm

1994

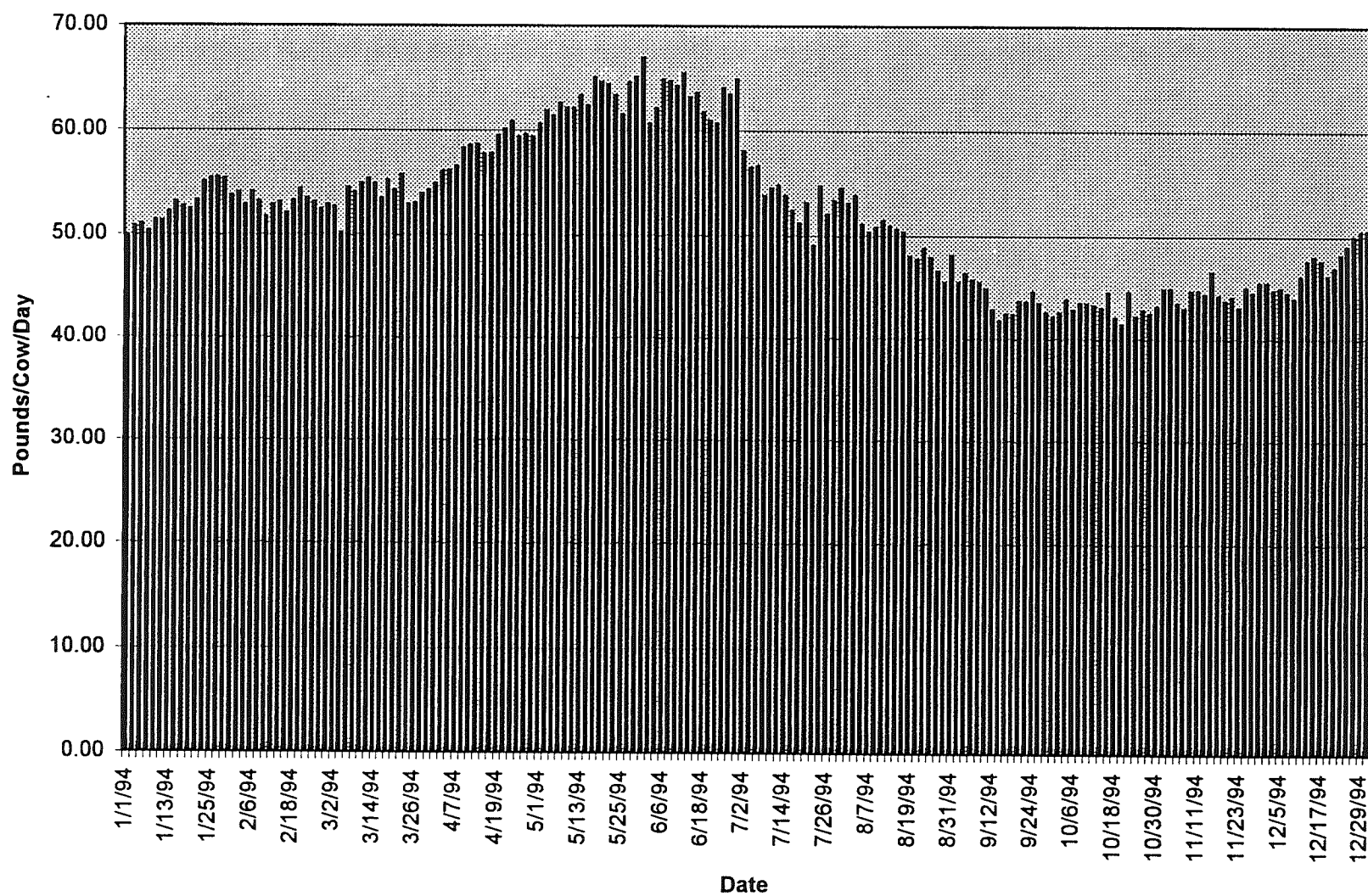
12/17/94	3,427.00	36.00	47.60	14,517.15	
12/19/94	3,328.00	36.00	46.22	14,097.78	
12/21/94	3,378.00	36.00	46.92	14,309.58	
12/23/94	3,469.00	36.00	48.18	14,695.07	
12/25/94	3,531.00	36.00	49.04	14,957.71	
12/27/94	3,801.00	38.00	50.01	15,254.01	
12/29/94	3,935.00	39.00	50.45	15,386.86	
12/31/94	3,943.00	39.00	50.55	15,418.14	45.00
1/2/95	3,900.00	39.00	56.17	17,132.59	
1/4/95	3,995.00	39.00	61.77	18,839.20	
1/6/95	4,191.00	41.00	64.68	19,726.96	
1/8/95	4,351.00	41.00	63.39	19,334.82	
1/10/95	4,464.00	41.00	59.81	18,242.16	
1/12/95	4,593.00	41.00	60.97	18,594.48	
1/14/95	4,622.00	41.00	61.21	18,668.10	
1/16/95	4,741.00	41.00	62.36	19,020.43	
1/18/95	4,626.00	41.00	75.00	22,875.00	
1/20/95	4,780.00	41.00	76.00	23,180.00	
1/22/95	4,808.00	42.00	82.85	25,268.08	
1/24/95	4,826.00	42.00	90.23	27,519.90	
1/26/95	4,829.00	42.00	92.02	28,066.35	
1/28/95	4,985.00	43.00	92.35	28,168.02	
1/30/95	4,982.00	43.00	89.25	27,221.25	
2/1/95	4,799.00	43.00	89.83	27,399.17	
2/3/95	4,705.00	43.00	88.42	26,967.08	
2/5/95	4,712.00	43.00	97.79	29,826.46	
2/7/95	4,796.00	43.00	87.31	26,630.31	

Milk Production on the Lonnie Nelson Farm

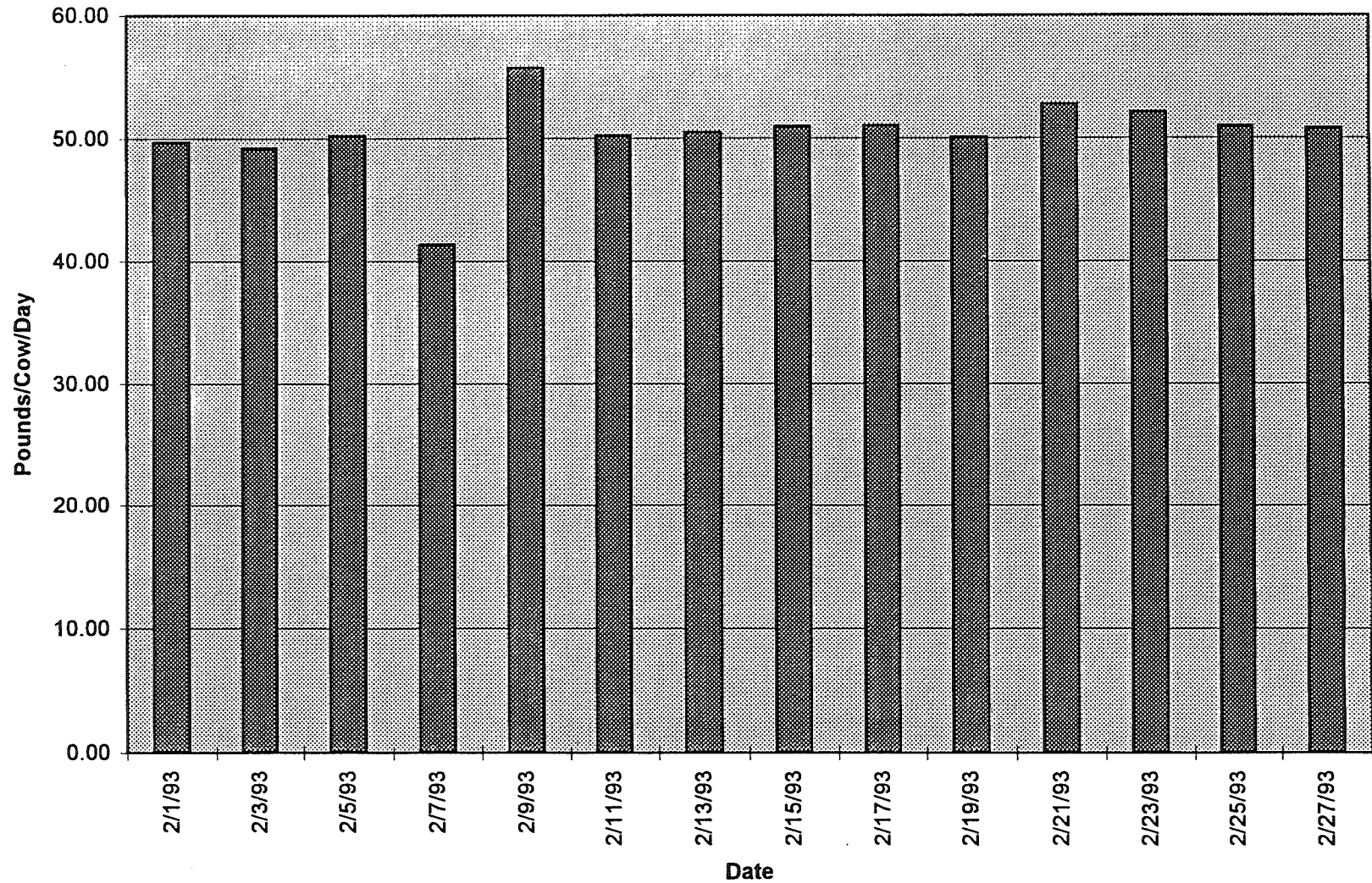


1994

Milk Production on the Lonnie Nelson Farm

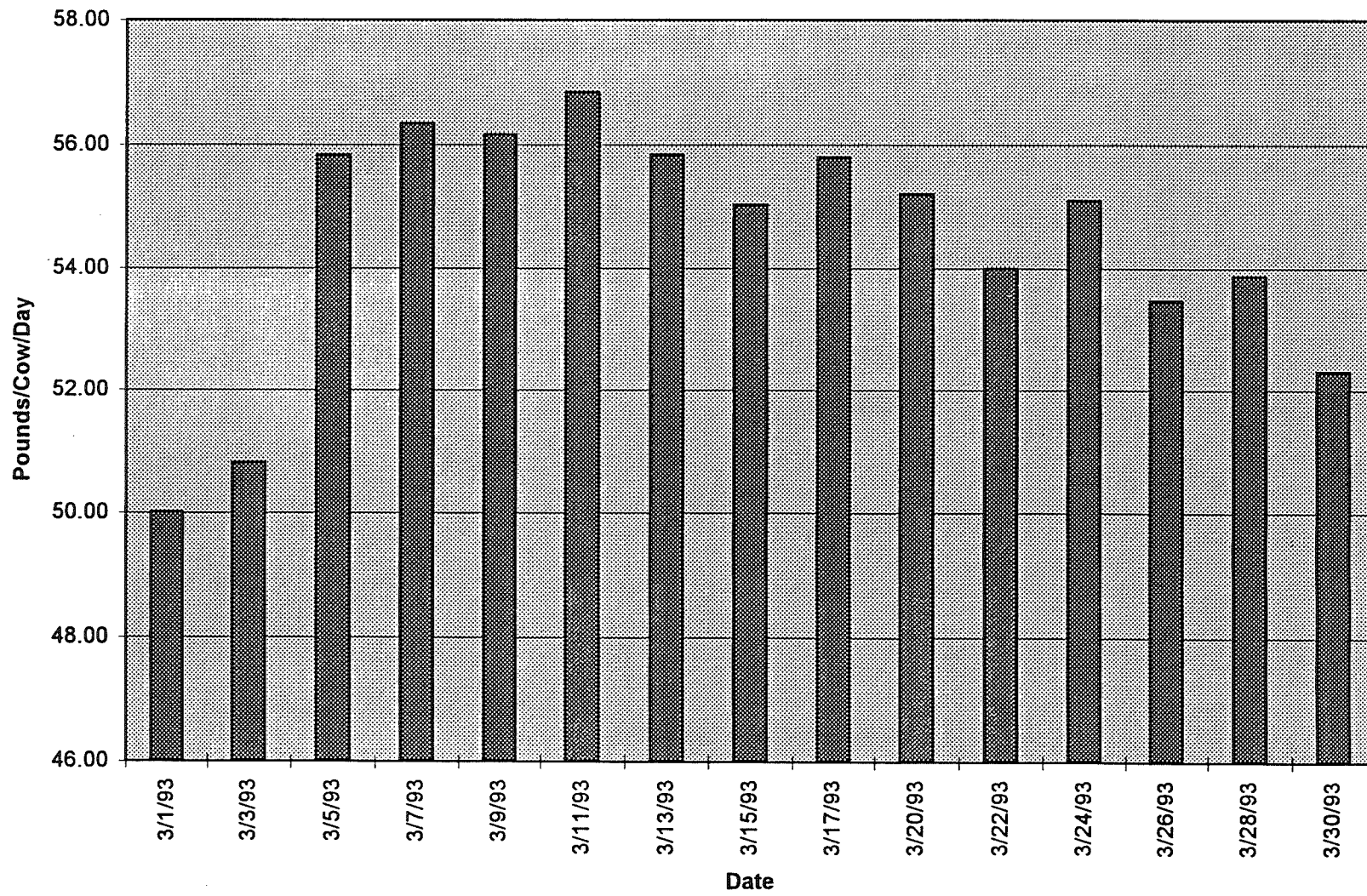


Milk Production on the Lonnie Nelson Farm



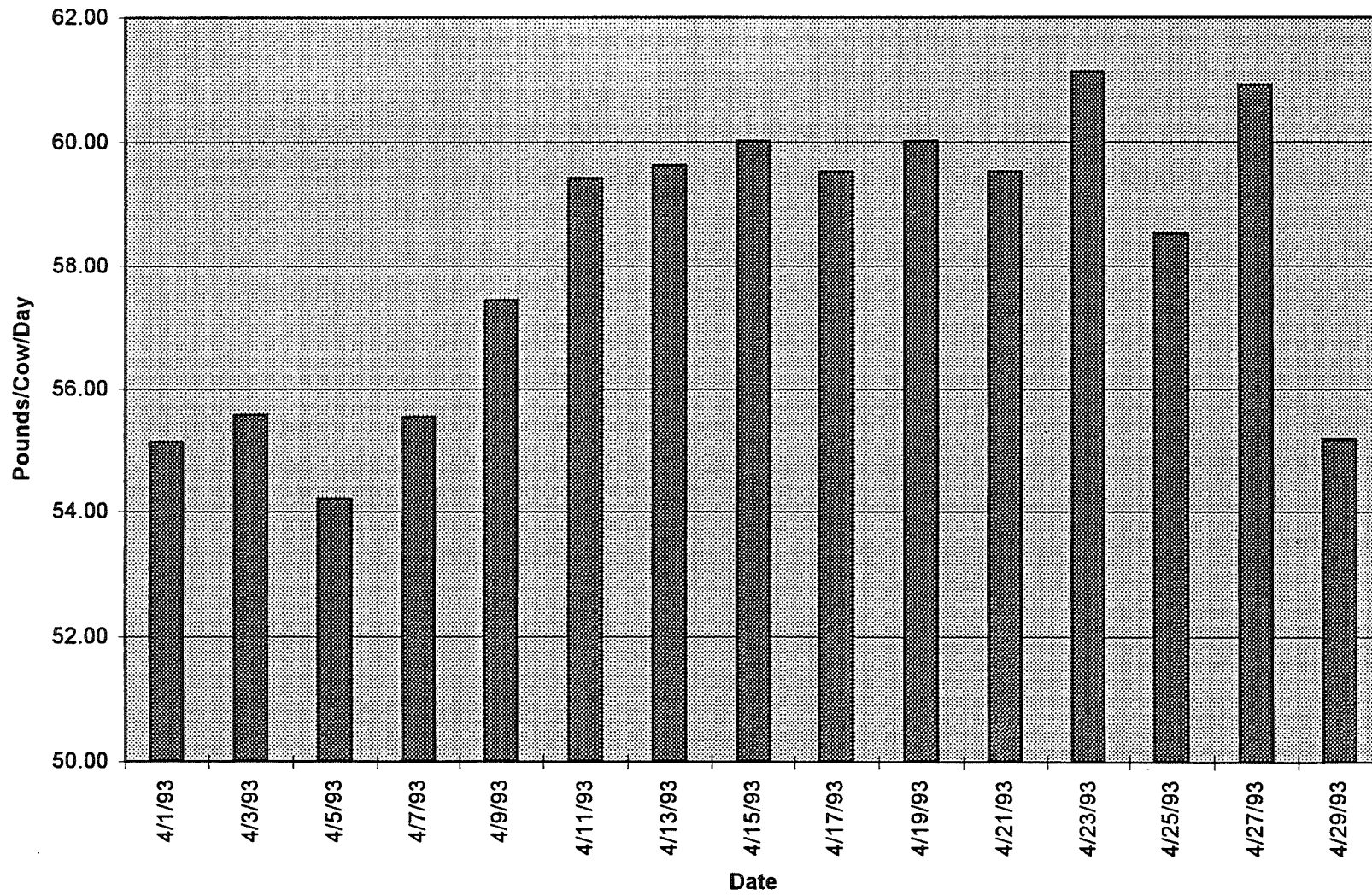
March 1993

Milk Production on the Lonnie Nelson Farm

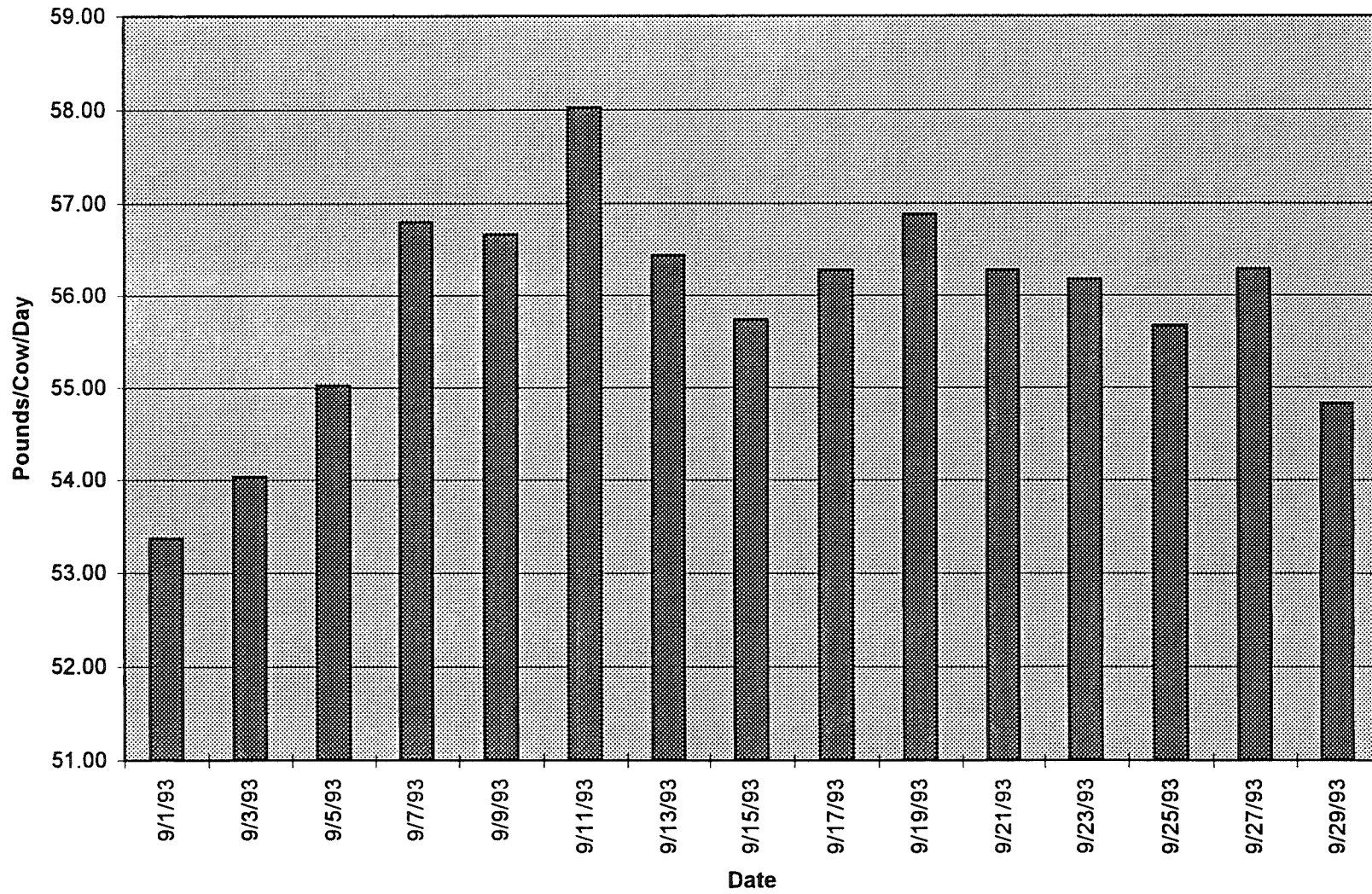


April 1993

Milk Production on the Lonnie Nelson Farm

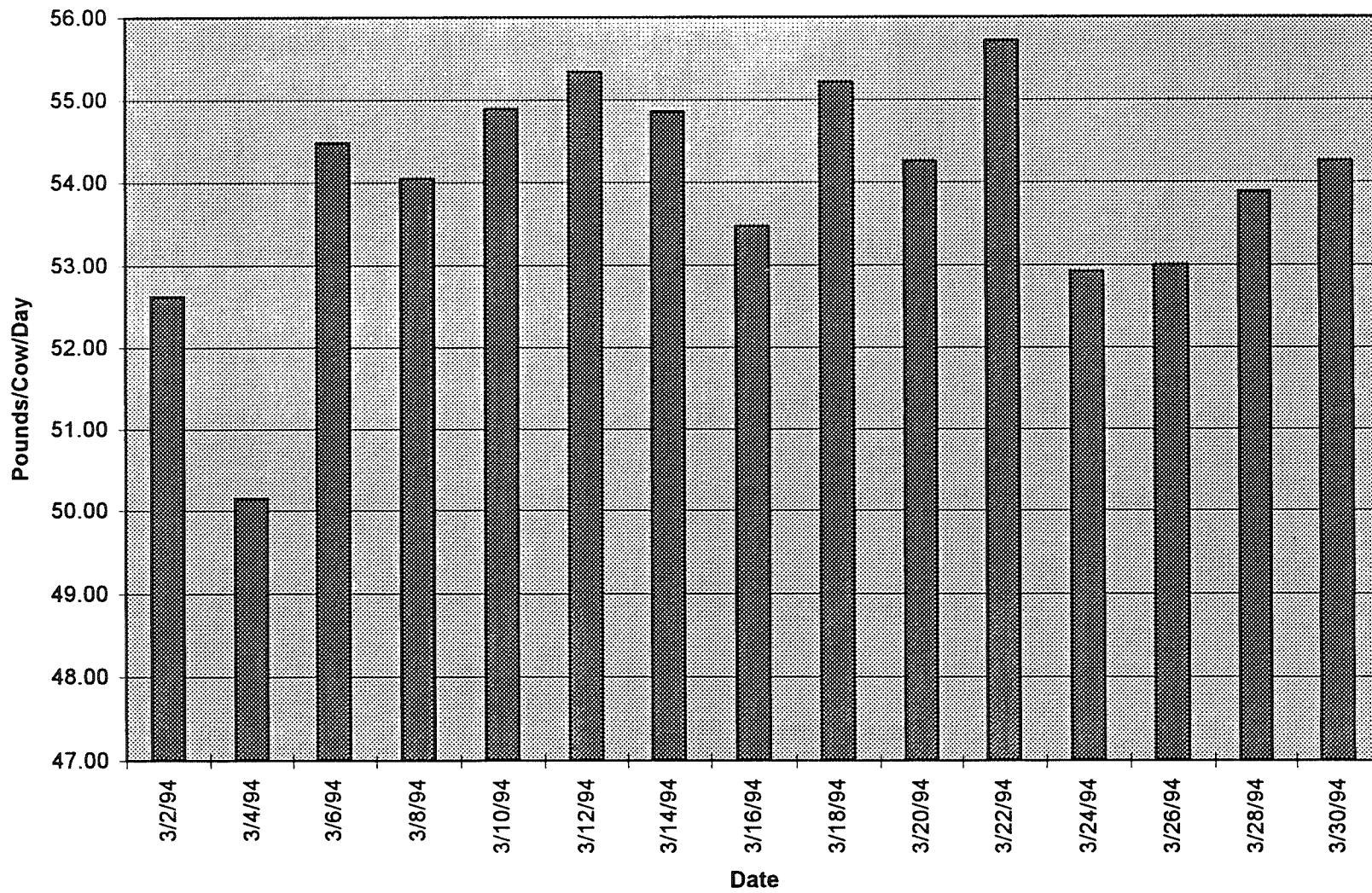


Milk Production on the Lonnie Nelson Farm



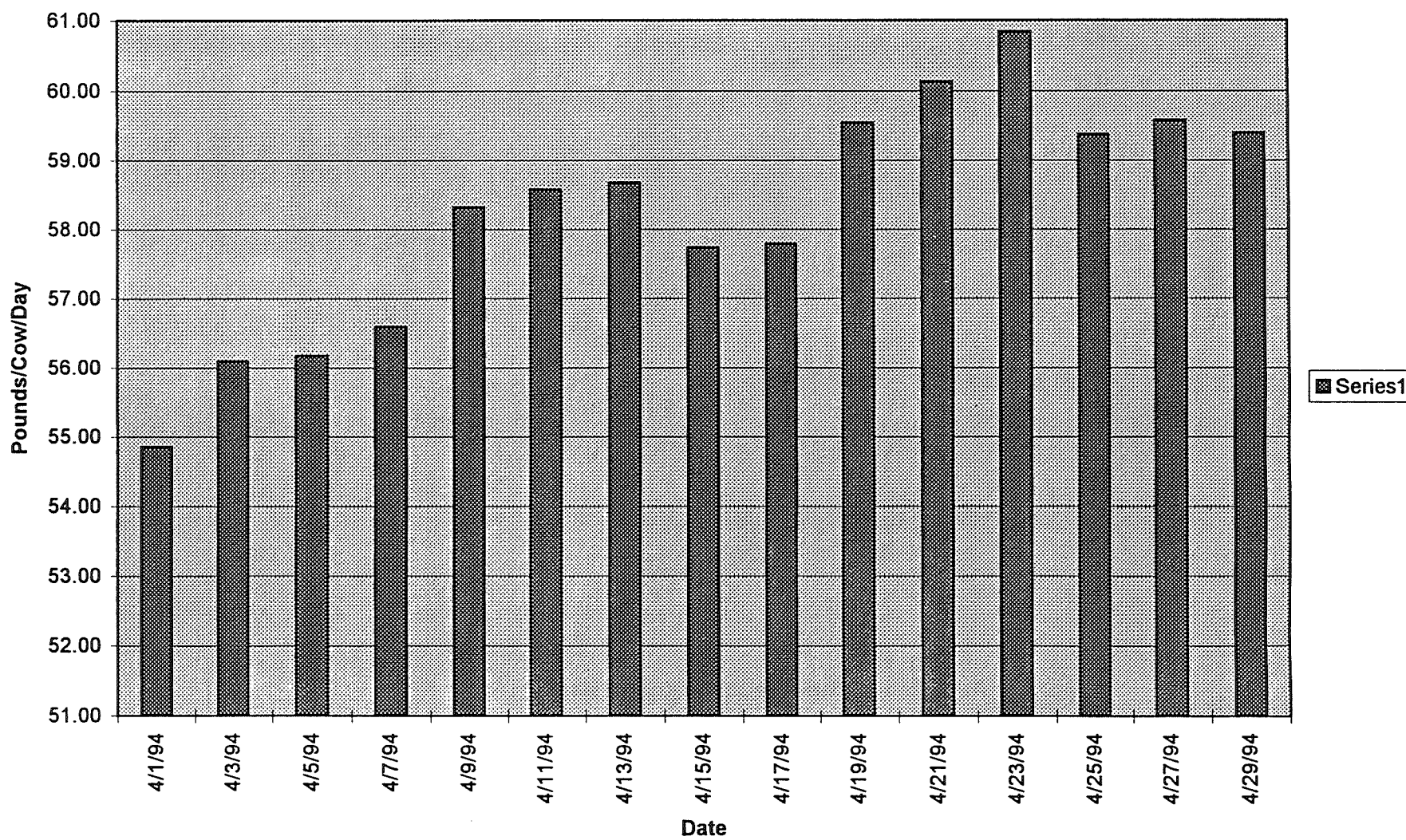
March 1994

Milk Production on the Lonnie Nelson Farm



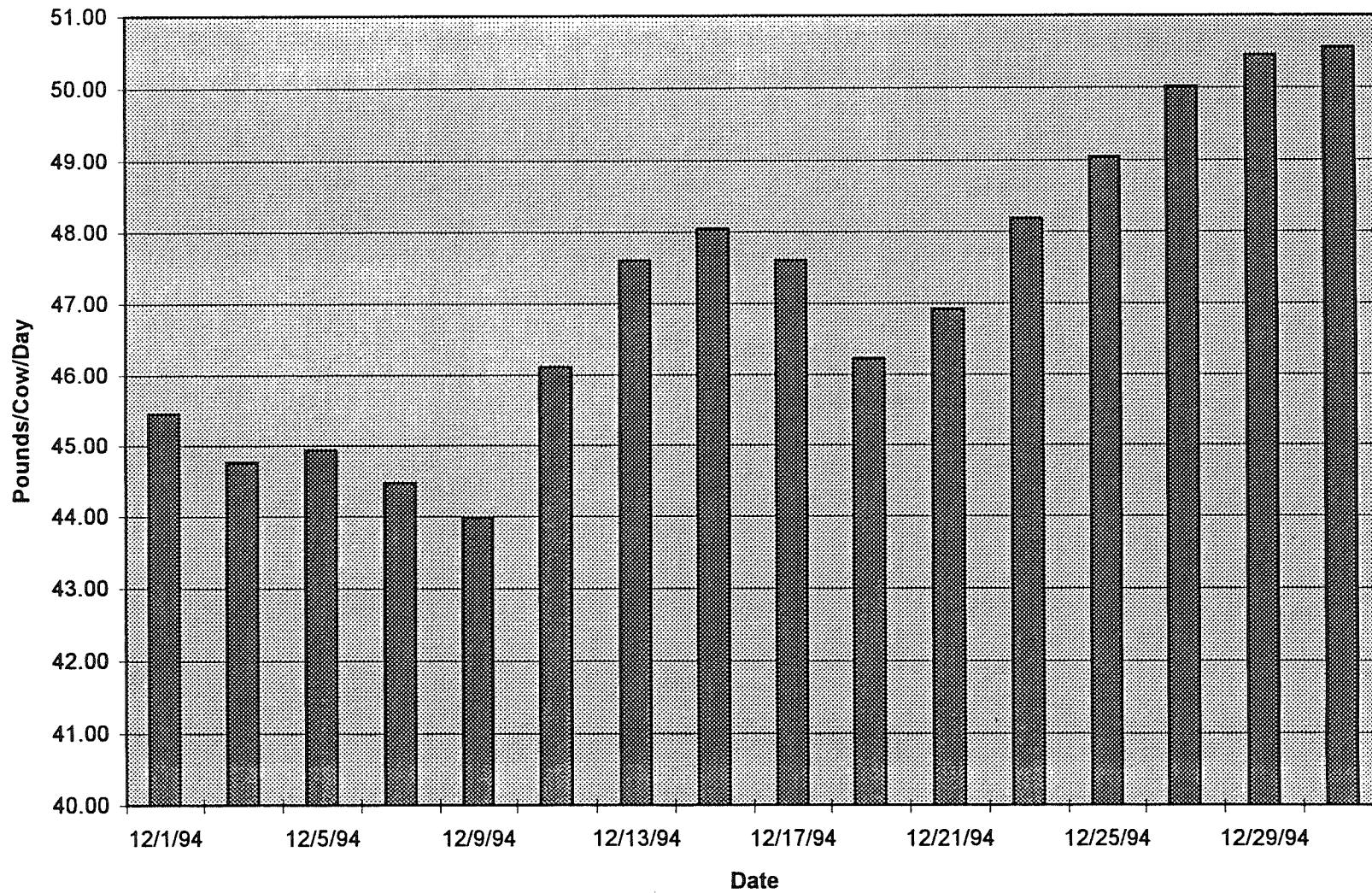
April 1994

Milk Production on the Lonnie Nelson Farm



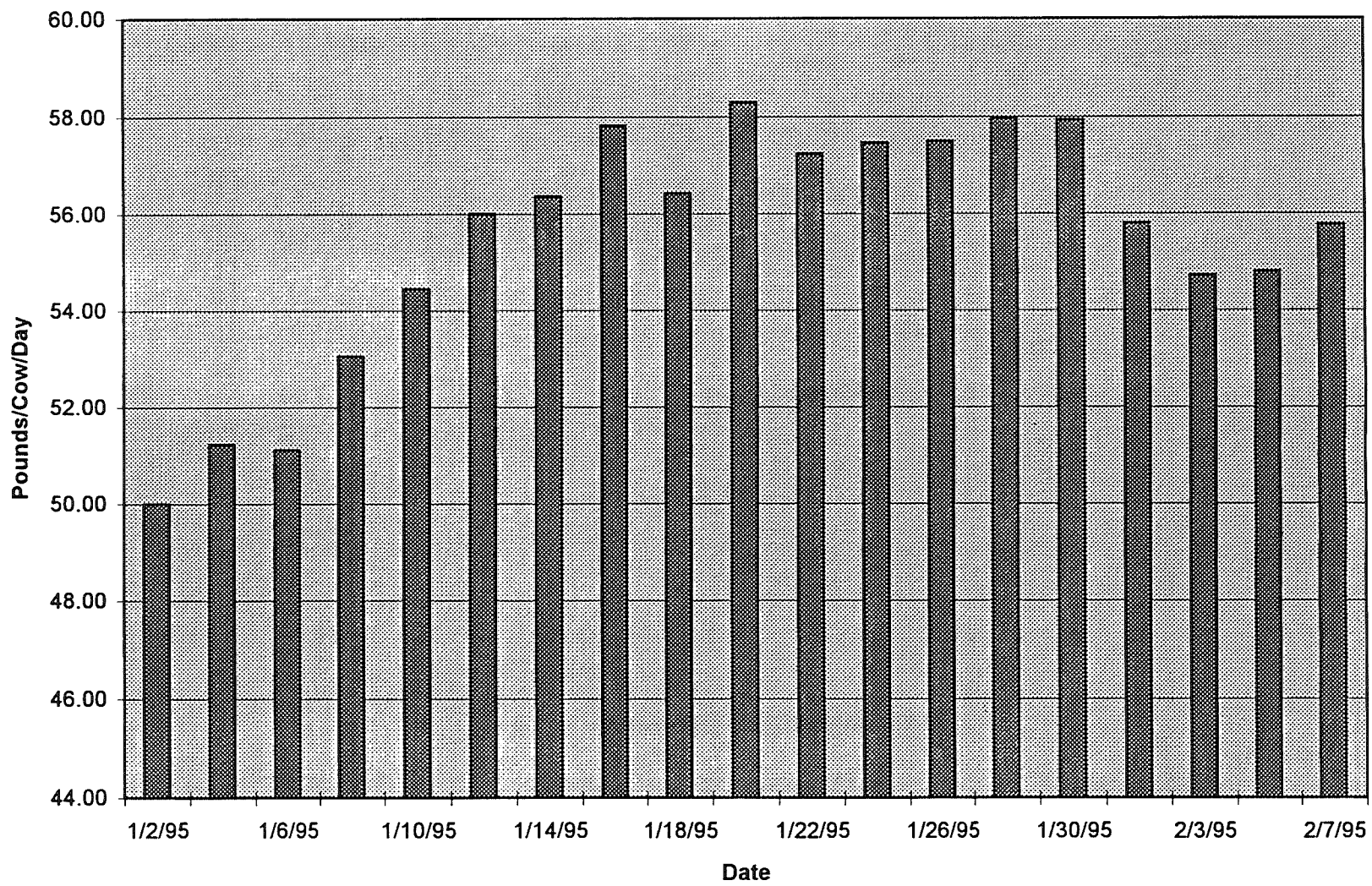
December 1994

Milk Production on the Lonnie Nelson Farm



1995

Milk Production on the Nelson Farm



Water Consumption
on the Lonnie Nelson Farm

Date	AM Gallons	PM Gallons	Gallons	# of Cows	Gallons/Cow	Gallons/Cow	Gallons/Cow
	Total	Total	Total		AM	PM	Total
1/24/92			0	30			0.00
1/25/92			550	30			18.33
1/26/92			0	30			0.00
1/27/92			0	30			0.00
1/28/92			0	30			0.00
1/29/92			0	30			0.00
1/30/92			410	30			13.67
1/31/92			430	30			14.33
2/1/92			440	29			15.17
2/2/92			510	30			17.00
2/3/92			610	30			20.33
2/4/92			1330	30			44.33
2/5/92			720	30			24.00
2/6/92			690	30			23.00
2/7/92			390	30			13.00
2/8/92			550	30			18.33
2/9/92			530	30			17.67
2/10/92			470	30			15.67
2/11/92			480	30			16.00
2/12/92			440	30			14.67
2/13/92			480	30			16.00
2/14/92			460	30			15.33
2/15/92			500	30			16.67
2/16/92			440	30			14.67
2/17/92			380	30			12.67
2/18/92			420	30			14.00
2/19/92			480	31			15.48
2/20/92			470	31			15.16
2/21/92			450	31			14.52
2/22/92			460	31			14.84
2/23/92			500	31			16.13
2/24/92			620	31			20.00
2/25/92			440	31			14.19
2/26/92			490	31			15.81
2/27/92			460	31			14.84
2/28/92			560	31			18.06
2/29/92			490	31			15.81
3/1/92			510	31			16.45
3/2/92			590	31			19.03
3/3/92			660	31			21.29
3/4/92			520	31			16.77
3/5/92			510	31			16.45
3/6/92			530	31			17.10
3/7/92			450	31			14.52
3/8/92			500	31			16.13
3/9/92			550	31			17.74
3/10/92			510	31			16.45
3/11/92			560	31			18.06
3/12/92			500	31			16.13

1992

Water Consumption
on the Lonnie Nelson Farm

1994

3/13/92			530	34		15.59
3/14/92			560	34		16.47
3/15/92			610	34		17.94
3/16/92			590	34		17.35
3/17/92			590	34		17.35
18						0.00
3/19/92			1180	34		34.71
3/20/92			640	34		18.82
3/21/92			610	34		17.94
3/22/92			590	34		17.35
3/23/92			640	34		18.82
3/24/92			1110	34		32.65
3/25/92			600	34		17.65
3/26/92			610	34		17.94
3/27/92			700	34		20.59
3/28/92			670	34		19.71
3/29/92			720	34		21.18
3/30/92			630	34		18.53
3/31/92			670	34		19.71
4/1/92			700	34		20.59
4/2/92			750	34		22.06
4/3/92			720	34		21.18
4/4/92			740	34		21.76
4/5/92			720	34		21.18
4/6/92			820	34		24.12
4/7/92			690	34		20.29
4/8/92			720	34		21.18
4/9/92			660	34		19.41
4/10/92			690	34		20.29
4/11/92			620	34		18.24
4/12/92			700	34		20.59
4/13/92			680	34		20.00
4/14/92			700	34		20.59
4/15/92			680	34		20.00
4/16/92			1790	34		52.65
4/17/92			740	34		21.76
4/18/92			750	34		22.06
4/19/92			700	34		20.59
4/20/92			680	34		20.00
4/21/92			690	34		20.29
4/22/92			700	34		20.59
4/23/92			710	34		20.88
4/24/92			760	34		22.35
4/25/92			750	34		22.06
4/26/92			790	34		23.24
4/27/92			910	34		26.76
4/28/92			800	34		23.53
4/29/92			860	34		25.29
4/30/92			890	34		26.18
5/1/92			1370	34		40.29
5/2/92			800	34		23.53

1992

Water Consumption
on the Lonnie Nelson Farm

1994

5/3/92		780	34		22.94
5/4/92		830	34		24.41
5/5/92		830	34		24.41
5/6/92		910	34		26.76
5/7/92		890	34		26.18
5/8/92		910	34		26.76
5/10/92		890	34		26.18
5/11/92		800	34		23.53
5/12/92		750	34		22.06
5/13/92		1070	34		31.47
5/14/92		850	34		25.00
5/15/92		780	34		22.94
5/16/92		790	34		23.24
5/17/92		810	34		23.82
5/18/92		1110	34		32.65
5/19/92		970	34		28.53
5/20/92		890	34		26.18
5/21/92		830	34		24.41
5/22/92		760	34		22.35
5/24/92		1420	34		41.76
5/25/92		760	34		22.35
5/26/92		940	34		27.65
5/27/92		820	34		24.12
33,752.00		950	34		27.94
5/29/92		830	31		26.77
5/30/92		850	31		27.42
5/31/92		820	31		26.45
6/1/92		750	31		24.19
6/2/92		810	31		26.13
6/3/92		760	31		24.52
6/4/92		790	31		25.48
6/5/92		730	31		23.55
6/6/92		880	31		28.39
6/7/92		720	31		23.23
6/8/92		770	31		24.84
6/9/92		950	31		30.65
6/10/92		780	31		25.16
6/11/92		1150	31		37.10
6/12/92		2260	31		72.90
6/13/92		1320	31		42.58
6/14/92		660	31		21.29
6/15/92		510	31		16.45
6/16/92		670	31		21.61
6/17/92		750	31		24.19
6/18/92		540	31		17.42
6/19/92		650	31		20.97
6/20/92		1050	31		33.87
6/21/92		660	31		21.29
6/22/92		700	31		22.58
6/23/92		1270	31		40.97
6/24/92		1410	31		45.48

1992

Water Consumption
on the Lonnie Nelson Farm

1994

6/25/92		1210	31		39.03
6/27/92		650	31		20.97
6/28/92		710	31		22.90
6/29/92		560	31		18.06
6/30/92		610	31		19.68
7/1/92		810	31		26.13
7/2/92		710	31		22.90
7/3/92		850	31		27.42
7/4/92		730	31		23.55
7/5/92		600	31		19.35
7/6/92		650	31		20.97
7/7/92		720	31		23.23
7/8/92		730	31		23.55
7/9/92		610	31		19.68
7/10/92		650	31		20.97
7/11/92		630	31		20.32
7/12/92		690	31		22.26
7/13/92		630	31		20.32
7/14/92		0	0		0.00
7/20/92		0	31		0.00
7/21/92		680	31		21.94
7/22/92		650	31		20.97
7/23/92		680	31		21.94
7/24/92		530	34		15.59
7/25/92		640	34		18.82
7/26/92		760	34		22.35
7/27/92		680	34		20.00
7/28/92		670	34		19.71
7/29/92		870	34		25.59
7/30/92		690	34		20.29
7/31/92		700	34		20.59
8/1/92		700	34		20.59
8/2/92		670	34		19.71
8/3/92		1030	34		30.29
8/4/92		800	34		23.53
8/5/92		720	34		21.18
8/6/92		670	34		19.71
8/7/92		650	34		19.12
8/8/92		750	34		22.06
8/9/92		800	34		23.53
8/10/92		730	34		21.47
8/11/92		650	34		19.12
8/12/92		800	34		23.53
8/13/92		740	34		21.76
8/14/92		750	34		22.06
8/15/92		970	34		28.53
8/16/92		730	34		21.47
8/17/92		710	34		20.88
8/18/92		660	34		19.41
8/19/92		660	34		19.41
8/20/92		930	34		27.35

1992

Water Consumption
on the Lonnie Nelson Farm

1994

8/21/92		660	34		19.41
8/22/92		720	34		21.18
8/23/92		880	34		25.88
8/24/92		590	34		17.35
8/25/92		640	35		18.29
8/26/92		730	35		20.86
8/27/92		770	35		22.00
8/28/92		740	35		21.14
8/29/92		670	35		19.14
8/30/92		610	35		17.43
8/31/92		740	35		21.14
9/1/92		600	35		17.14
9/2/92		700	35		20.00
9/3/92		600	35		17.14
9/4/92		740	35		21.14
9/5/92		710	35		20.29
9/6/92		720	35		20.57
9/7/92		660	35		18.86
9/8/92		640	35		18.29
9/9/92		290	35		8.29
9/10/92		650	35		18.57
9/11/92		690	35		19.71
9/12/92		770	35		22.00
9/13/92		730	35		20.86
9/14/92		770	35		22.00
9/15/92		700	35		20.00
9/16/92		610	35		17.43
9/17/92		630	35		18.00
9/18/92		570	35		16.29
9/19/92		620	35		17.71
9/20/92		610	35		17.43
9/21/92		630	35		18.00
9/22/92		570	35		16.29
9/23/92		650	35		18.57
9/24/92		590	35		16.86
9/25/92		600	35		17.14
9/26/92		620	35		17.71
9/27/92		770	35		22.00
9/28/92		580	35		16.57
9/29/92		700	35		20.00
9/30/92		760	35		21.71
10/1/92		720	35		20.57
10/2/92		1660	35		47.43
10/3/92		1140	35		32.57
10/4/92		1140	35		32.57
10/5/92		730	35		20.86
10/6/92		680	35		19.43
10/7/92		920	36		25.56
10/8/92		600	36		16.67
10/9/92		670	36		18.61
10/10/92		660	36		18.33

Water Consumption
on the Lonnie Nelson Farm

10/11/92		1050	36		29.17
10/12/92		610	36		16.94
10/13/92		670	36		18.61
10/14/92		620	36		17.22
10/15/92		560	36		15.56
10/16/92		520	36		14.44
10/17/92		560	36		15.56
10/18/92		570	36		15.83
10/19/92		610	36		16.94
10/20/92		560	36		15.56
10/21/92		740	37		20.00
10/22/92		1090	37		29.46
10/23/92		600	37		16.22
10/24/92		610	37		16.49
10/25/92		690	37		18.65
10/26/92		640	37		17.30
10/27/92		1120	37		30.27
10/28/92		680	37		18.38
10/29/92		610	37		16.49
10/30/92		620	37		16.76
10/31/92		630	37		17.03
11/1/92		590	37		15.95
11/2/92		670	37		18.11
11/3/92		580	37		15.68
11/4/92		590	37		15.95
11/5/92		580	37		15.68
11/6/92		540	37		14.59
11/7/92		630	37		17.03
11/8/92		590	37		15.95
11/9/92		540	37		14.59
11/10/92		630	37		17.03
11/11/92		620	37		16.76
11/12/92		570	37		15.41
11/13/92		610	37		16.49
11/14/92		640	36		17.78
11/15/92		570	36		15.83
11/16/92		760	36		21.11
11/17/92		620	36		17.22
11/18/92		620	36		17.22
11/19/92		530	36		14.72
11/20/92		580	36		16.11
11/21/92		630	36		17.50
11/22/92		700	36		19.44
11/23/92		600	36		16.67
11/24/92		610	36		16.94
11/25/92		590	36		16.39
11/26/92		570	36		15.83
11/27/92		610	36		16.94
11/28/92		610	36		16.94
11/29/92		600	36		16.67
11/30/92		590	36		16.39

Water Consumption
on the Lonnie Nelson Farm

1/1/93	170.00	580.00	750.00	38.00	4.47	15.26	19.74
1/2/93	160.00	570.00	730.00	38.00	4.21	15.00	19.21
1/3/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/4/93	140.00	530.00	670.00	38.00	3.68	13.95	17.63
1/5/93	160.00	550.00	710.00	38.00	4.21	14.47	18.68
1/6/93	140.00	550.00	690.00	38.00	3.68	14.47	18.16
1/7/93	150.00	550.00	700.00	38.00	3.95	14.47	18.42
1/8/93	170.00	580.00	750.00	38.00	4.47	15.26	19.74
1/9/93	170.00	620.00	790.00	38.00	4.47	16.32	20.79
1/10/93	160.00	600.00	760.00	38.00	4.21	15.79	20.00
1/11/93	170.00	630.00	800.00	38.00	4.47	16.58	21.05
1/12/93	140.00	610.00	750.00	38.00	3.68	16.05	19.74
1/13/93	150.00	630.00	780.00	38.00	3.95	16.58	20.53
1/14/93	200.00	620.00	820.00	38.00	5.26	16.32	21.58
1/15/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/16/93	190.00	650.00	840.00	38.00	5.00	17.11	22.11
1/17/93	180.00	650.00	830.00	38.00	4.74	17.11	21.84
1/18/93	130.00	630.00	760.00	38.00	3.42	16.58	20.00
1/19/93	170.00	640.00	810.00	38.00	4.47	16.84	21.32
1/20/93	170.00	640.00	810.00	38.00	4.47	16.84	21.32
1/21/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/22/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/23/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/24/93	270.00	600.00	870.00	37.00	7.30	16.22	23.51
1/25/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/26/93	260.00	620.00	880.00	37.00	7.03	16.76	23.78
1/27/93	160.00	550.00	710.00	38.00	4.21	14.47	18.68
1/28/93	220.00	620.00	840.00	38.00	5.79	16.32	22.11
1/29/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/30/93	230.00	600.00	830.00	38.00	6.05	15.79	21.84
1/31/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2/1/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2/2/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2/3/93	210.00	630.00	840.00	38.00	5.53	16.58	22.11
2/4/93	220.00	600.00	820.00	38.00	5.79	15.79	21.58
2/5/93	220.00	630.00	850.00	38.00	5.79	16.58	22.37
2/6/93	220.00	580.00	800.00	38.00	5.79	15.26	21.05
2/7/93	240.00	630.00	870.00	38.00	6.32	16.58	22.89
2/8/93	220.00	610.00	830.00	38.00	5.79	16.05	21.84
2/9/93	270.00	650.00	920.00	38.00	7.11	17.11	24.21
2/10/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2/11/93	300.00	730.00	1,030.00	38.00	7.89	19.21	27.11
2/12/93	190.00	660.00	850.00	38.00	5.00	17.37	22.37
2/13/93	250.00	680.00	930.00	38.00	6.58	17.89	24.47
2/14/93	190.00	610.00	800.00	38.00	5.00	16.05	21.05
2/15/93	320.00	720.00	1,040.00	38.00	8.42	18.95	27.37
2/16/93	260.00	670.00	930.00	38.00	6.84	17.63	24.47
2/17/93	250.00	640.00	890.00	38.00	6.58	16.84	23.42
2/18/93	210.00	790.00	1,000.00	38.00	5.53	20.79	26.32
2/19/93	230.00	640.00	870.00	38.00	6.05	16.84	22.89
2/20/93	250.00	690.00	940.00	38.00	6.58	18.16	24.74

Water Consumption
on the Lonnie Nelson Farm

2/21/93	210.00	730.00	940.00	38.00	5.53	19.21	24.74
2/22/93	220.00	720.00	940.00	38.00	5.79	18.95	24.74
2/23/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2/24/93	230.00	0.00	230.00	38.00	6.05	0.00	6.05
2/25/93	120.00	560.00	680.00	38.00	3.16	14.74	17.89
2/26/93	280.00	710.00	990.00	38.00	7.37	18.68	26.05
2/27/93	270.00	710.00	980.00	37.00	7.30	19.19	26.49
2/28/93	200.00	650.00	850.00	37.00	5.41	17.57	22.97
3/1/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3/2/93	230.00	670.00	900.00	37.00	6.22	18.11	24.32
3/3/93	220.00	650.00	870.00	37.00	5.95	17.57	23.51
3/4/93	220.00	680.00	900.00	37.00	5.95	18.38	24.32
3/5/93	220.00	680.00	900.00	36.00	6.11	18.89	25.00
3/6/93	190.00	650.00	840.00	36.00	5.28	18.06	23.33
3/7/93	250.00	670.00	920.00	36.00	6.94	18.61	25.56
3/8/93	240.00	630.00	870.00	36.00	6.67	17.50	24.17
3/9/93	260.00	650.00	910.00	36.00	7.22	18.06	25.28
3/10/93	230.00	630.00	860.00	36.00	6.39	17.50	23.89
3/11/93	220.00	640.00	860.00	36.00	6.11	17.78	23.89
3/12/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3/13/93	170.00	620.00	790.00	36.00	4.72	17.22	21.94
3/14/93	190.00	610.00	800.00	36.00	5.28	16.94	22.22
3/15/93	190.00	650.00	840.00	36.00	5.28	18.06	23.33
3/16/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3/17/93	200.00	650.00	850.00	36.00	5.56	18.06	23.61
3/18/93	190.00	650.00	840.00	36.00	5.28	18.06	23.33
3/19/93	190.00	680.00	870.00	36.00	5.28	18.89	24.17
3/20/93	140.00	610.00	750.00	36.00	3.89	16.94	20.83
3/21/93	170.00	650.00	820.00	36.00	4.72	18.06	22.78
3/22/93	140.00	640.00	780.00	36.00	3.89	17.78	21.67
3/23/93	200.00	710.00	910.00	36.00	5.56	19.72	25.28
3/24/93	150.00	640.00	790.00	36.00	4.17	17.78	21.94
3/25/93	160.00	600.00	760.00	36.00	4.44	16.67	21.11
3/26/93	200.00	710.00	910.00	36.00	5.56	19.72	25.28
3/27/93	150.00	640.00	790.00	36.00	4.17	17.78	21.94
3/28/93	230.00	720.00	950.00	36.00	6.39	20.00	26.39
3/29/93	160.00	670.00	830.00	36.00	4.44	18.61	23.06
3/30/93	130.00	570.00	700.00	36.00	3.61	15.83	19.44
3/31/93	160.00	610.00	770.00	36.00	4.44	16.94	21.39
4/1/93	140.00	590.00	730.00	36.00	3.89	16.39	20.28
4/2/93	160.00	610.00	770.00	36.00	4.44	16.94	21.39
4/3/93	150.00	590.00	740.00	36.00	4.17	16.39	20.56
4/4/93	130.00	590.00	720.00	36.00	3.61	16.39	20.00
4/5/93	140.00	630.00	770.00	36.00	3.89	17.50	21.39
4/6/93	210.00	660.00	870.00	36.00	5.83	18.33	24.17
4/7/93	180.00	630.00	810.00	36.00	5.00	17.50	22.50
4/8/93	220.00	570.00	790.00	36.00	6.11	15.83	21.94
4/9/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4/10/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4/11/93	230.00	650.00	880.00	36.00	6.39	18.06	24.44
4/12/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Water Consumption
on the Lonnie Nelson Farm

4/13/93	170.00	560.00	730.00	26.00	6.54	21.54	28.08
4/14/93	170.00	550.00	720.00	26.00	6.54	21.15	27.69
4/15/93	150.00	490.00	640.00	26.00	5.77	18.85	24.62
4/16/93	150.00	540.00	690.00	26.00	5.77	20.77	26.54
4/17/93	160.00	550.00	710.00	26.00	6.15	21.15	27.31
4/18/93	160.00	540.00	700.00	27.00	5.93	20.00	25.93
4/19/93	140.00	530.00	670.00	27.00	5.19	19.63	24.81
4/20/93	170.00	550.00	720.00	27.00	6.30	20.37	26.67
4/21/93	140.00	560.00	700.00	27.00	5.19	20.74	25.93
4/22/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4/23/93	150.00	520.00	670.00	27.00	5.56	19.26	24.81
4/24/93	170.00	530.00	700.00	27.00	6.30	19.63	25.93
4/25/93	170.00	490.00	660.00	27.00	6.30	18.15	24.44
4/26/93	200.00	610.00	810.00	27.00	7.41	22.59	30.00
4/27/93	140.00	490.00	630.00	27.00	5.19	18.15	23.33
4/28/93	220.00	650.00	870.00	29.00	7.59	22.41	30.00
4/29/93	180.00	510.00	690.00	27.00	6.67	18.89	25.56
4/30/93	210.00	540.00	750.00	27.00	7.78	20.00	27.78
5/1/93	200.00	530.00	730.00	28.00	7.14	18.93	26.07
5/2/93	180.00	570.00	750.00	28.00	6.43	20.36	26.79
5/3/93	160.00	560.00	720.00	28.00	5.71	20.00	25.71
5/4/93	170.00	580.00	750.00	28.00	6.07	20.71	26.79
5/5/93	200.00	600.00	800.00	28.00	7.14	21.43	28.57
5/6/93	230.00	650.00	880.00	29.00	7.93	22.41	30.34
5/7/93	200.00	670.00	870.00	29.00	6.90	23.10	30.00
5/8/93	180.00	580.00	760.00	31.00	5.81	18.71	24.52
5/9/93	250.00	650.00	900.00	31.00	8.06	20.97	29.03
5/10/93	220.00	400.00	620.00	31.00	7.10	12.90	20.00
5/11/93	200.00	690.00	890.00	32.00	6.25	21.56	27.81
5/12/93	220.00	760.00	980.00	32.00	6.88	23.75	30.63
5/13/93	200.00	710.00	910.00	33.00	6.06	21.52	27.58
5/14/93	270.00	790.00	1,060.00	33.00	8.18	23.94	32.12
5/15/93	200.00	660.00	860.00	33.00	6.06	20.00	26.06
5/16/93	220.00	690.00	910.00	33.00	6.67	20.91	27.58
5/17/93	220.00	690.00	910.00	33.00	6.67	20.91	27.58
5/18/93	240.00	630.00	870.00	33.00	7.27	19.09	26.36
5/19/93	290.00	700.00	990.00	33.00	8.79	21.21	30.00
5/20/93	260.00	700.00	960.00	33.00	7.88	21.21	29.09
5/21/93	210.00	670.00	880.00	33.00	6.36	20.30	26.67
5/22/93	240.00	650.00	890.00	33.00	7.27	19.70	26.97
5/23/93	280.00	690.00	970.00	36.00	7.78	19.17	26.94
5/24/93	260.00	680.00	940.00	37.00	7.03	18.38	25.41
5/25/93	240.00	620.00	860.00	37.00	6.49	16.76	23.24
5/26/93	290.00	750.00	1,040.00	37.00	7.84	20.27	28.11
5/27/93	300.00	730.00	1,030.00	37.00	8.11	19.73	27.84
5/28/93	260.00	740.00	1,000.00	37.00	7.03	20.00	27.03
5/29/93	300.00	840.00	1,140.00	37.00	8.11	22.70	30.81
5/30/93	290.00	800.00	1,090.00	37.00	7.84	21.62	29.46
5/31/93	330.00	860.00	1,190.00	37.00	8.92	23.24	32.16
6/1/93	260.00	790.00	1,050.00	37.00	7.03	21.35	28.38
6/2/93	360.00	860.00	1,220.00	37.00	9.73	23.24	32.97

Water Consumption
on the Lonnie Nelson Farm

6/3/93	280.00	810.00	1,090.00	37.00	7.57	21.89	29.46
6/4/93	230.00	530.00	760.00	37.00	6.22	14.32	20.54
6/5/93	230.00	610.00	840.00	37.00	6.22	16.49	22.70
6/6/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/7/93	390.00	650.00	1,040.00	37.00	10.54	17.57	28.11
6/8/93	250.00	630.00	880.00	37.00	6.76	17.03	23.78
6/7/93	210.00	650.00	860.00	37.00	5.68	17.57	23.24
6/10/93	220.00	670.00	890.00	37.00	5.95	18.11	24.05
6/11/93	310.00	790.00	1,100.00	37.00	8.38	21.35	29.73
6/12/93	310.00	780.00	1,090.00	37.00	8.38	21.08	29.46
6/13/93	310.00	850.00	1,160.00	37.00	8.38	22.97	31.35
6/14/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/15/93	280.00	780.00	1,060.00	37.00	7.57	21.08	28.65
6/16/93	310.00	820.00	1,130.00	37.00	8.38	22.16	30.54
6/17/93	400.00	900.00	1,300.00	37.00	10.81	24.32	35.14
6/18/93	230.00	620.00	850.00	37.00	6.22	16.76	22.97
6/19/93	230.00	610.00	840.00	37.00	6.22	16.49	22.70
6/20/93	240.00	660.00	900.00	37.00	6.49	17.84	24.32
6/21/93	210.00	700.00	910.00	37.00	5.68	18.92	24.59
6/22/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/23/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/24/93	340.00	910.00	1,250.00	37.00	9.19	24.59	33.78
6/25/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/26/93	310.00	910.00	1,220.00	37.00	8.38	24.59	32.97
6/27/93	220.00	860.00	1,080.00	37.00	5.95	23.24	29.19
6/28/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/29/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/30/93	320.00	880.00	1,200.00	37.00	8.65	23.78	32.43
7/1/93	350.00	940.00	1,290.00	37.00	9.46	25.41	34.86
7/2/93	400.00	1,090.00	1,490.00	37.00	10.81	29.46	40.27
7/3/93	310.00	890.00	1,200.00	37.00	8.38	24.05	32.43
7/4/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7/5/93	380.00	1,030.00	1,410.00	38.00	10.00	27.11	37.11
7/6/93	330.00	910.00	1,240.00	38.00	8.68	23.95	32.63
7/7/93	350.00	940.00	1,290.00	38.00	9.21	24.74	33.95
7/8/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7/9/93	400.00	940.00	1,340.00	38.00	10.53	24.74	35.26
7/10/93	470.00	1,060.00	1,530.00	37.00	12.70	28.65	41.35
7/11/93	430.00	960.00	1,390.00	37.00	11.62	25.95	37.57
7/12/93	330.00	960.00	1,290.00	37.00	8.92	25.95	34.86
7/13/93	330.00	870.00	1,200.00	37.00	8.92	23.51	32.43
7/14/93	350.00	920.00	1,270.00	37.00	9.46	24.86	34.32
7/15/93	330.00	870.00	1,200.00	37.00	8.92	23.51	32.43
7/16/93	350.00	990.00	1,340.00	37.00	9.46	26.76	36.22
7/17/93	350.00	1,050.00	1,400.00	37.00	9.46	28.38	37.84
7/18/93	380.00	1,020.00	1,400.00	37.00	10.27	27.57	37.84
7/19/93	340.00	940.00	1,280.00	37.00	9.19	25.41	34.59
7/20/93	360.00	1,030.00	1,390.00	37.00	9.73	27.84	37.57
7/21/93	430.00	940.00	1,370.00	35.00	12.29	26.86	39.14
7/22/93	390.00	840.00	1,230.00	35.00	11.14	24.00	35.14
7/23/93	390.00	850.00	1,240.00	35.00	11.14	24.29	35.43

Water Consumption
on the Lonnie Nelson Farm

7/24/93	300.00	860.00	1,160.00	35.00	8.57	24.57	33.14
7/25/93	340.00	850.00	1,190.00	35.00	9.71	24.29	34.00
7/26/93	300.00	900.00	1,200.00	35.00	8.57	25.71	34.29
7/27/93	340.00	1,050.00	1,390.00	35.00	9.71	30.00	39.71
7/28/93	340.00	820.00	1,160.00	35.00	9.71	23.43	33.14
7/29/93	380.00	840.00	1,220.00	35.00	10.86	24.00	34.86
7/30/93	360.00	1,080.00	1,440.00	35.00	10.29	30.86	41.14
7/31/93	410.00	1,000.00	1,410.00	36.00	11.39	27.78	39.17
8/1/93	360.00	920.00	1,280.00	36.00	10.00	25.56	35.56
8/2/93	350.00	1,000.00	1,350.00	36.00	9.72	27.78	37.50
8/3/93	340.00	840.00	1,180.00	36.00	9.44	23.33	32.78
8/4/93	340.00	930.00	1,270.00	36.00	9.44	25.83	35.28
8/5/93	360.00	950.00	1,310.00	37.00	9.73	25.68	35.41
8/6/93	380.00	950.00	1,330.00	37.00	10.27	25.68	35.95
8/7/93	380.00	1,020.00	1,400.00	37.00	10.27	27.57	37.84
8/8/93	350.00	1,080.00	1,430.00	37.00	9.46	29.19	38.65
8/9/93	410.00	1,100.00	1,510.00	38.00	10.79	28.95	39.74
8/10/93	400.00	1,210.00	1,610.00	38.00	10.53	31.84	42.37
8/11/93	410.00	1,040.00	1,450.00	38.00	10.79	27.37	38.16
8/12/93	390.00	1,010.00	1,400.00	38.00	10.26	26.58	36.84
8/13/93	350.00	990.00	1,340.00	38.00	9.21	26.05	35.26
8/14/93	390.00	1,030.00	1,420.00	38.00	10.26	27.11	37.37
8/15/93	370.00	980.00	1,350.00	38.00	9.74	25.79	35.53
8/16/93	370.00	980.00	1,350.00	38.00	9.74	25.79	35.53
8/17/93	340.00	1,030.00	1,370.00	38.00	8.95	27.11	36.05
8/18/93	340.00	910.00	1,250.00	38.00	8.95	23.95	32.89
8/19/93	340.00	1,070.00	1,410.00	38.00	8.95	28.16	37.11
8/20/93	330.00	880.00	1,210.00	38.00	8.68	23.16	31.84
8/21/93	420.00	980.00	1,400.00	38.00	11.05	25.79	36.84
8/22/93	390.00	950.00	1,340.00	38.00	10.26	25.00	35.26
8/23/93	350.00	1,040.00	1,390.00	38.00	9.21	27.37	36.58
8/24/93	390.00	1,000.00	1,390.00	39.00	10.00	25.64	35.64
8/25/93	370.00	1,010.00	1,380.00	39.00	9.49	25.90	35.38
8/26/93	400.00	970.00	1,370.00	39.00	10.26	24.87	35.13
8/27/93	360.00	940.00	1,300.00	39.00	9.23	24.10	33.33
8/28/93	320.00	950.00	1,270.00	39.00	8.21	24.36	32.56
8/29/93	360.00	940.00	1,300.00	39.00	9.23	24.10	33.33
8/30/93	390.00	920.00	1,310.00	40.00	9.75	23.00	32.75
8/31/93	370.00	1,010.00	1,380.00	40.00	9.25	25.25	34.50
9/1/93	330.00	920.00	1,250.00	40.00	8.25	23.00	31.25
9/2/93	390.00	950.00	1,340.00	40.00	9.75	23.75	33.50
9/3/93	380.00	1,000.00	1,380.00	40.00	9.50	25.00	34.50
9/4/93	430.00	1,080.00	1,510.00	40.00	10.75	27.00	37.75
9/5/93	360.00	990.00	1,350.00	40.00	9.00	24.75	33.75
9/6/93	400.00	1,060.00	1,460.00	40.00	10.00	26.50	36.50
9/7/93	360.00	950.00	1,310.00	40.00	9.00	23.75	32.75
9/8/93	400.00	1,110.00	1,510.00	40.00	10.00	27.75	37.75
9/9/93	340.00	940.00	1,280.00	40.00	8.50	23.50	32.00
9/10/93	340.00	970.00	1,310.00	40.00	8.50	24.25	32.75
9/11/93	350.00	1,010.00	1,360.00	40.00	8.75	25.25	34.00
9/12/93	350.00	1,090.00	1,440.00	40.00	8.75	27.25	36.00

Water Consumption
on the Lonnie Nelson Farm

9/13/93	340.00	910.00	1,250.00	40.00	8.50	22.75	31.25
9/14/93	330.00	900.00	1,230.00	39.00	8.46	23.08	31.54
9/15/93	290.00	820.00	1,110.00	39.00	7.44	21.03	28.46
9/16/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/17/93	340.00	900.00	1,240.00	39.00	8.72	23.08	31.79
9/18/93	240.00	890.00	1,130.00	39.00	6.15	22.82	28.97
9/19/93	340.00	850.00	1,190.00	40.00	8.50	21.25	29.75
9/20/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/21/93	380.00	940.00	1,320.00	40.00	9.50	23.50	33.00
9/22/93	350.00	860.00	1,210.00	40.00	8.75	21.50	30.25
9/23/93	290.00	820.00	1,110.00	40.00	7.25	20.50	27.75
9/24/93	290.00	770.00	1,060.00	40.00	7.25	19.25	26.50
9/25/93	410.00	950.00	1,360.00	40.00	10.25	23.75	34.00
9/26/93	360.00	920.00	1,280.00	40.00	9.00	23.00	32.00
9/27/93	360.00	890.00	1,250.00	40.00	9.00	22.25	31.25
9/28/93	310.00	680.00	990.00	40.00	7.75	17.00	24.75
9/29/93	340.00	930.00	1,270.00	40.00	8.50	23.25	31.75
9/30/93	300.00	820.00	1,120.00	40.00	7.50	20.50	28.00
10/1/93	360.00	730.00	1,090.00	40.00	9.00	18.25	27.25
10/2/93	340.00	800.00	1,140.00	38.00	8.95	21.05	30.00
10/3/93	350.00	900.00	1,250.00	38.00	9.21	23.68	32.89
10/4/93	280.00	790.00	1,070.00	39.00	7.18	20.26	27.44
10/5/93	310.00	840.00	1,150.00	39.00	7.95	21.54	29.49
10/6/93	340.00	940.00	1,280.00	39.00	8.72	24.10	32.82
10/7/93	320.00	780.00	1,100.00	38.00	8.42	20.53	28.95
10/8/93	300.00	880.00	1,180.00	38.00	7.89	23.16	31.05
10/9/93	220.00	770.00	990.00	38.00	5.79	20.26	26.05
10/10/93	240.00	790.00	1,030.00	39.00	6.15	20.26	26.41
10/11/93	310.00	830.00	1,140.00	39.00	7.95	21.28	29.23
10/12/93	300.00	830.00	1,130.00	39.00	7.69	21.28	28.97
10/13/93	230.00	770.00	1,000.00	39.00	5.90	19.74	25.64
10/14/93	270.00	840.00	1,110.00	39.00	6.92	21.54	28.46
10/15/93	240.00	790.00	1,030.00	39.00	6.15	20.26	26.41
10/16/93	230.00	790.00	1,020.00	39.00	5.90	20.26	26.15
10/17/93	220.00	740.00	960.00	40.00	5.50	18.50	24.00
10/18/93	290.00	760.00	1,050.00	40.00	7.25	19.00	26.25
10/19/93	310.00	830.00	1,140.00	40.00	7.75	20.75	28.50
10/20/93	280.00	800.00	1,080.00	40.00	7.00	20.00	27.00
10/21/93	250.00	710.00	960.00	40.00	6.25	17.75	24.00
10/22/93	290.00	870.00	1,160.00	40.00	7.25	21.75	29.00
10/23/93	280.00	810.00	1,090.00	40.00	7.00	20.25	27.25
10/24/93	310.00	820.00	1,130.00	40.00	7.75	20.50	28.25
10/25/93	290.00	830.00	1,120.00	40.00	7.25	20.75	28.00
10/26/93	300.00	900.00	1,200.00	40.00	7.50	22.50	30.00
10/27/93	240.00	780.00	1,020.00	40.00	6.00	19.50	25.50
10/28/93	360.00	850.00	1,210.00	40.00	9.00	21.25	30.25
10/29/93	290.00	790.00	1,080.00	40.00	7.25	19.75	27.00
10/30/93	260.00	800.00	1,060.00	40.00	6.50	20.00	26.50
10/31/93	240.00	810.00	1,050.00	40.00	6.00	20.25	26.25
11/1/93	0 DC	0 DC	0.00	40.00	0.00	0.00	0.00
11/2/93	340.00	840.00	1,180.00	40.00	8.50	21.00	29.50

Water Consumption
on the Lonnie Nelson Farm

11/3/93	250.00	830.00	1,080.00	40.00	6.25	20.75	27.00
11/4/93	250.00	790.00	1,040.00	40.00	6.25	19.75	26.00
11/5/93	220.00	730.00	950.00	40.00	5.50	18.25	23.75
11/6/93	280.00	800.00	1,080.00	40.00	7.00	20.00	27.00
11/7/93	240.00	760.00	1,000.00	40.00	6.00	19.00	25.00
11/8/93	240.00	730.00	970.00	40.00	6.00	18.25	24.25
11/9/93	320.00	790.00	1,110.00	40.00	8.00	19.75	27.75
11/10/93	290.00	820.00	1,110.00	40.00	7.25	20.50	27.75
11/11/93	260.00	770.00	1,030.00	40.00	6.50	19.25	25.75
11/12/93	280.00	770.00	1,050.00	40.00	7.00	19.25	26.25
11/13/93	250.00	740.00	990.00	40.00	6.25	18.50	24.75
11/14/93	280.00	780.00	1,060.00	40.00	7.00	19.50	26.50
11/15/93	300.00	800.00	1,100.00	40.00	7.50	20.00	27.50
11/16/93	250.00	750.00	1,000.00	40.00	6.25	18.75	25.00
11/17/93	280.00	770.00	1,050.00	40.00	7.00	19.25	26.25
11/18/93	240.00	770.00	1,010.00	40.00	6.00	19.25	25.25
11/19/93	200.00	660.00	860.00	40.00	5.00	16.50	21.50
11/20/93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/21/93	230.00	740.00	970.00	40.00	5.75	18.50	24.25
11/22/93	210.00	770.00	980.00	40.00	5.25	19.25	24.50
11/23/93	240.00	750.00	990.00	40.00	6.00	18.75	24.75
11/24/93	260.00	730.00	990.00	40.00	6.50	18.25	24.75
11/25/93	250.00	680.00	930.00	40.00	6.25	17.00	23.25
11/26/93	300.00	760.00	1,060.00	40.00	7.50	19.00	26.50
11/27/93	260.00	760.00	1,020.00	40.00	6.50	19.00	25.50
11/28/93	240.00	740.00	980.00	39.00	6.15	18.97	25.13
11/29/93	230.00	720.00	950.00	39.00	5.90	18.46	24.36
11/30/93	200.00	680.00	880.00	39.00	5.13	17.44	22.56
12/1/93	280.00	770.00	1,050.00	39.00	7.18	19.74	26.92
12/2/93	230.00	680.00	910.00	40.00	5.75	17.00	22.75
12/3/93	260.00	750.00	1,010.00	40.00	6.50	18.75	25.25
12/4/93	230.00	720.00	950.00	39.00	5.90	18.46	24.36
12/5/93	250.00	770.00	1,020.00	39.00	6.41	19.74	26.15
12/6/93	220.00	730.00	950.00	39.00	5.64	18.72	24.36
12/7/93	240.00	710.00	950.00	40.00	6.00	17.75	23.75
12/8/93	300.00	810.00	1,110.00	40.00	7.50	20.25	27.75
12/9/93	260.00	800.00	1,060.00	40.00	6.50	20.00	26.50
12/10/93	250.00	790.00	1,040.00	40.00	6.25	19.75	26.00
12/11/93	240.00	750.00	990.00	40.00	6.00	18.75	24.75
12/12/93	230.00	680.00	910.00	40.00	5.75	17.00	22.75
12/13/93	280.00	840.00	1,120.00	40.00	7.00	21.00	28.00
12/14/93	260.00	750.00	1,010.00	40.00	6.50	18.75	25.25
12/15/93	320.00	850.00	1,170.00	40.00	8.00	21.25	29.25
12/16/93	220.00	780.00	1,000.00	40.00	5.50	19.50	25.00
12/17/93	280.00	770.00	1,050.00	40.00	7.00	19.25	26.25
12/18/93	320.00	820.00	1,140.00	40.00	8.00	20.50	28.50
12/19/93	280.00	760.00	1,040.00	40.00	7.00	19.00	26.00
12/20/93	270.00	730.00	1,000.00	40.00	6.75	18.25	25.00
12/21/93	310.00	750.00	1,060.00	40.00	7.75	18.75	26.50
12/22/93	320.00	850.00	1,170.00	40.00	8.00	21.25	29.25
12/23/93	270.00	770.00	1,040.00	40.00	6.75	19.25	26.00

Water Consumption
on the Lonnie Nelson Farm

12/24/93	310.00	840.00	1,150.00	40.00	7.75	21.00	28.75
12/25/93	310.00	810.00	1,120.00	40.00	7.75	20.25	28.00
12/26/93	240.00	750.00	990.00	40.00	6.00	18.75	24.75
12/27/93	310.00	810.00	1,120.00	40.00	7.75	20.25	28.00
12/28/93	250.00	770.00	1,020.00	40.00	6.25	19.25	25.50
12/29/93	300.00	800.00	1,100.00	40.00	7.50	20.00	27.50
12/30/93	300.00	800.00	1,100.00	40.00	7.50	20.00	27.50
12/31/93	280.00	770.00	1,050.00	39.00	7.18	19.74	26.92
1/1/94	280.00	840.00	1,120.00	39.00	7.18	21.54	28.72
1/2/94	250.00	770.00	1,020.00	40.00	6.25	19.25	25.50
1/3/94	230.00	730.00	960.00	40.00	5.75	18.25	24.00
1/4/93	280.00	770.00	1,050.00	40.00	7.00	19.25	26.25
1/5/94	250.00	810.00	1,060.00	39.00	6.41	20.77	27.18
1/6/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/7/94	240.00	740.00	980.00	39.00	6.15	18.97	25.13
1/8/94	250.00	770.00	1,020.00	40.00	6.25	19.25	25.50
1/9/94	210.00	650.00	860.00	40.00	5.25	16.25	21.50
1/10/94	290.00	840.00	1,130.00	40.00	7.25	21.00	28.25
1/11/94	250.00	750.00	1,000.00	40.00	6.25	18.75	25.00
1/12/94	290.00	810.00	1,100.00	40.00	7.25	20.25	27.50
1/13/94	290.00	790.00	1,080.00	40.00	7.25	19.75	27.00
1/14/94	320.00	770.00	1,090.00	40.00	8.00	19.25	27.25
1/15/94	240.00	700.00	940.00	40.00	6.00	17.50	23.50
1/16/94	310.00	800.00	1,110.00	40.00	7.75	20.00	27.75
1/17/94	260.00	720.00	980.00	40.00	6.50	18.00	24.50
1/18/94	280.00	820.00	1,100.00	40.00	7.00	20.50	27.50
1/19/94	250.00	750.00	1,000.00	40.00	6.25	18.75	25.00
1/20/94	260.00	750.00	1,010.00	40.00	6.50	18.75	25.25
1/21/94	270.00	790.00	1,060.00	40.00	6.75	19.75	26.50
1/22/94	300.00	780.00	1,080.00	39.00	7.69	20.00	27.69
1/23/94	240.00	770.00	1,010.00	39.00	6.15	19.74	25.90
1/24/94	270.00	740.00	1,010.00	39.00	6.92	18.97	25.90
1/25/94	310.00	810.00	1,120.00	39.00	7.95	20.77	28.72
1/26/94	260.00	780.00	1,040.00	39.00	6.67	20.00	26.67
1/30/01	280.00	790.00	1,070.00	39.00	7.18	20.26	27.44
1/28/94	250.00	770.00	1,020.00	39.00	6.41	19.74	26.15
1/29/94	260.00	760.00	1,020.00	39.00	6.67	19.49	26.15
1/30/91	300.00	800.00	1,100.00	39.00	7.69	20.51	28.21
1/31/94	240.00	750.00	990.00	39.00	6.15	19.23	25.38
2/1/94	250.00	740.00	990.00	39.00	6.41	18.97	25.38
2/2/94	240.00	720.00	960.00	39.00	6.15	18.46	24.62
2/3/94	250.00	750.00	1,000.00	39.00	6.41	19.23	25.64
2/4/94	220.00	760.00	980.00	39.00	5.64	19.49	25.13
2/5/94	230.00	790.00	1,020.00	40.00	5.75	19.75	25.50
2/6/94	240.00	860.00	1,100.00	40.00	6.00	21.50	27.50
2/7/94	210.00	860.00	1,070.00	40.00	5.25	21.50	26.75
2/8/94	260.00	900.00	1,160.00	40.00	6.50	22.50	29.00
2/9/94	210.00	810.00	1,020.00	40.00	5.25	20.25	25.50
2/10/94	300.00	910.00	1,210.00	40.00	7.50	22.75	30.25
2/11/94	300.00	940.00	1,240.00	40.00	7.50	23.50	31.00
2/12/94	290.00	860.00	1,150.00	40.00	7.25	21.50	28.75

Water Consumption
on the Lonnie Nelson Farm

2/13/94	310.00	960.00	1,270.00	39.00	7.95	24.62	32.56
2/14/94	260.00	800.00	1,060.00	39.00	6.67	20.51	27.18
2/15/94	320.00	960.00	1,280.00	39.00	8.21	24.62	32.82
2/16/94	250.00	870.00	1,120.00	39.00	6.41	22.31	28.72
2/17/94	290.00	910.00	1,200.00	39.00	7.44	23.33	30.77
2/18/94	290.00	900.00	1,190.00	39.00	7.44	23.08	30.51
2/19/94	340.00	900.00	1,240.00	39.00	8.72	23.08	31.79
2/20/94	310.00	970.00	1,280.00	39.00	7.95	24.87	32.82
2/21/94	270.00	910.00	1,180.00	39.00	6.92	23.33	30.26
2/22/94	230.00	790.00	1,020.00	40.00	5.75	19.75	25.50
2/23/94	250.00	830.00	1,080.00	40.00	6.25	20.75	27.00
2/24/94	220.00	800.00	1,020.00	40.00	5.50	20.00	25.50
2/25/94	280.00	900.00	1,180.00	40.00	7.00	22.50	29.50
2/26/94	250.00	880.00	1,130.00	40.00	6.25	22.00	28.25
2/27/94	230.00	780.00	1,010.00	40.00	5.75	19.50	25.25
2/28/94	320.00	920.00	1,240.00	40.00	8.00	23.00	31.00
3/1/94	210.00	840.00	1,050.00	40.00	5.25	21.00	26.25
3/2/94	240.00	880.00	1,120.00	40.00	6.00	22.00	28.00
3/3/94	200.00	750.00	950.00	40.00	5.00	18.75	23.75
3/4/94	250.00	830.00	1,080.00	39.00	6.41	21.28	27.69
3/5/94	250.00	870.00	1,120.00	39.00	6.41	22.31	28.72
3/6/94	190.00	790.00	980.00	39.00	4.87	20.26	25.13
3/7/94	230.00	810.00	1,040.00	39.00	5.90	20.77	26.67
3/8/94	230.00	780.00	1,010.00	39.00	5.90	20.00	25.90
3/9/94	260.00	850.00	1,110.00	39.00	6.67	21.79	28.46
3/10/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3/11/94	220.00	810.00	1,030.00	39.00	5.64	20.77	26.41
3/12/94	210.00	800.00	1,010.00	39.00	5.38	20.51	25.90
3/13/94	200.00	780.00	980.00	39.00	5.13	20.00	25.13
3/14/94	200.00	660.00	860.00	39.00	5.13	16.92	22.05
3/15/94	250.00	700.00	950.00	39.00	6.41	17.95	24.36
3/16/94	260.00	690.00	950.00	39.00	6.67	17.69	24.36
3/17/94	250.00	720.00	970.00	39.00	6.41	18.46	24.87
3/18/94	230.00	730.00	960.00	39.00	5.90	18.72	24.62
3/19/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3/20/94	230.00	760.00	990.00	39.00	5.90	19.49	25.38
3/21/94	220.00	730.00	950.00	39.00	5.64	18.72	24.36
3/22/94	210.00	700.00	910.00	39.00	5.38	17.95	23.33
3/23/94	220.00	690.00	910.00	39.00	5.64	17.69	23.33
3/24/94	250.00	750.00	1,000.00	39.00	6.41	19.23	25.64
3/25/94	230.00	750.00	980.00	39.00	5.90	19.23	25.13
3/26/94	210.00	680.00	890.00	39.00	5.38	17.44	22.82
3/27/94	230.00	700.00	930.00	39.00	5.90	17.95	23.85
3/28/94	240.00	710.00	950.00	39.00	6.15	18.21	24.36
3/29/94	220.00	690.00	910.00	40.00	5.50	17.25	22.75
3/30/94	250.00	740.00	990.00	40.00	6.25	18.50	24.75
3/31/94	270.00	730.00	1,000.00	40.00	6.75	18.25	25.00
4/1/94	230.00	800.00	1,030.00	35.00	6.57	22.86	29.43
4/2/94	240.00	780.00	1,020.00	35.00	6.86	22.29	29.14
4/3/94	220.00	740.00	960.00	35.00	6.29	21.14	27.43
4/4/94	290.00	770.00	1,060.00	35.00	8.29	22.00	30.29

Water Consumption
on the Lonnie Nelson Farm

4/5/94	260.00	790.00	1,050.00	35.00	7.43	22.57	30.00
4/6/94	250.00	770.00	1,020.00	35.00	7.14	22.00	29.14
4/7/94	270.00	820.00	1,090.00	35.00	7.71	23.43	31.14
4/8/94	290.00	750.00	1,040.00	35.00	8.29	21.43	29.71
4/9/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4/10/94	300.00	770.00	1,070.00	35.00	8.57	22.00	30.57
4/11/94	340.00	870.00	1,210.00	35.00	9.71	24.86	34.57
4/12/94	340.00	850.00	1,190.00	35.00	9.71	24.29	34.00
4/13/94	380.00	850.00	1,230.00	36.00	10.56	23.61	34.17
4/14/94	380.00	840.00	1,220.00	35.00	10.86	24.00	34.86
4/15/94	340.00	760.00	1,100.00	35.00	9.71	21.71	31.43
4/16/94	360.00	870.00	1,230.00	36.00	10.00	24.17	34.17
4/17/94	360.00	890.00	1,250.00	36.00	10.00	24.72	34.72
4/18/97	380.00	920.00	1,300.00	36.00	10.56	25.56	36.11
4/19/94	350.00	890.00	1,240.00	36.00	9.72	24.72	34.44
4/20/94	330.00	770.00	1,100.00	36.00	9.17	21.39	30.56
4/21/94	430.00	910.00	1,340.00	36.00	11.94	25.28	37.22
4/22/94	330.00	880.00	1,210.00	36.00	9.17	24.44	33.61
4/23/94	400.00	950.00	1,350.00	36.00	11.11	26.39	37.50
4/24/94	360.00	870.00	1,230.00	36.00	10.00	24.17	34.17
4/25/94	330.00	810.00	1,140.00	37.00	8.92	21.89	30.81
4/26/94	290.00	740.00	1,030.00	37.00	7.84	20.00	27.84
4/27/94	370.00	870.00	1,240.00	37.00	10.00	23.51	33.51
4/28/94	310.00	790.00	1,100.00	37.00	8.38	21.35	29.73
4/29/94	320.00	830.00	1,150.00	37.00	8.65	22.43	31.08
4/30/94	310.00	870.00	1,180.00	38.00	8.16	22.89	31.05
5/1/94	320.00	870.00	1,190.00	38.00	8.42	22.89	31.32
5/2/94	330.00	920.00	1,250.00	38.00	8.68	24.21	32.89
5/3/94	350.00	920.00	1,270.00	38.00	9.21	24.21	33.42
5/4/94	340.00	850.00	1,190.00	38.00	8.95	22.37	31.32
5/5/94	350.00	900.00	1,250.00	38.00	9.21	23.68	32.89
5/6/94	330.00	880.00	1,210.00	38.00	8.68	23.16	31.84
5/7/94	370.00	950.00	1,320.00	38.00	9.74	25.00	34.74
5/8/94	400.00	920.00	1,320.00	38.00	10.53	24.21	34.74
5/9/94	450.00	1,000.00	1,450.00	39.00	11.54	25.64	37.18
5/10/94	420.00	970.00	1,390.00	39.00	10.77	24.87	35.64
5/11/94	460.00	1,100.00	1,560.00	40.00	11.50	27.50	39.00
5/12/94	380.00	940.00	1,320.00	40.00	9.50	23.50	33.00
5/13/94	450.00	1,080.00	1,530.00	40.00	11.25	27.00	38.25
5/14/94	430.00	950.00	1,380.00	40.00	10.75	23.75	34.50
5/15/94	450.00	1,030.00	1,480.00	40.00	11.25	25.75	37.00
5/16/94	350.00	930.00	1,280.00	40.00	8.75	23.25	32.00
5/17/94	410.00	1,230.00	1,640.00	40.00	10.25	30.75	41.00
5/18/94	380.00	1,200.00	1,580.00	40.00	9.50	30.00	39.50
5/19/94	340.00	1,130.00	1,470.00	40.00	8.50	28.25	36.75
5/20/94	360.00	1,250.00	1,610.00	40.00	9.00	31.25	40.25
5/21/94	370.00	1,070.00	1,440.00	40.00	9.25	26.75	36.00
5/22/94	330.00	1,160.00	1,490.00	40.00	8.25	29.00	37.25
5/23/94	350.00	1,140.00	1,490.00	40.00	8.75	28.50	37.25
5/24/94	340.00	1,050.00	1,390.00	40.00	8.50	26.25	34.75
5/25/94	320.00	990.00	1,310.00	40.00	8.00	24.75	32.75

Water Consumption
on the Lonnie Nelson Farm

5/26/94	300.00	1,000.00	1,300.00	40.00	7.50	25.00	32.50
5/27/94	290.00	1,050.00	1,340.00	40.00	7.25	26.25	33.50
5/28/94	320.00	1,080.00	1,400.00	40.00	8.00	27.00	35.00
5/29/94	300.00	970.00	1,270.00	40.00	7.50	24.25	31.75
5/30/94	310.00	1,020.00	1,330.00	40.00	7.75	25.50	33.25
5/31/94	320.00	1,030.00	1,350.00	40.00	8.00	25.75	33.75
6/1/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/2/94	340.00	1,080.00	1,420.00	40.00	8.50	27.00	35.50
6/3/94	250.00	860.00	1,110.00	40.00	6.25	21.50	27.75
6/4/94	430.00	1,130.00	1,560.00	40.00	10.75	28.25	39.00
6/5/94	330.00	1,040.00	1,370.00	40.00	8.25	26.00	34.25
6/6/94	340.00	1,040.00	1,380.00	40.00	8.50	26.00	34.50
6/7/94	380.00	950.00	1,330.00	40.00	9.50	23.75	33.25
6/8/94	340.00	970.00	1,310.00	40.00	8.50	24.25	32.75
6/9/94	430.00	1,160.00	1,590.00	40.00	10.75	29.00	39.75
6/10/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/11/94	330.00	920.00	1,250.00	41.00	8.05	22.44	30.49
6/12/94	400.00	1,020.00	1,420.00	41.00	9.76	24.88	34.63
6/13/94	380.00	1,120.00	1,500.00	41.00	9.27	27.32	36.59
6/14/94	370.00	1,170.00	1,540.00	41.00	9.02	28.54	37.56
6/15/94	370.00	970.00	1,340.00	41.00	9.02	23.66	32.68
6/16/94	380.00	850.00	1,230.00	41.00	9.27	20.73	30.00
6/17/94	350.00	960.00	1,310.00	41.00	8.54	23.41	31.95
6/18/94	340.00	1,020.00	1,360.00	41.00	8.29	24.88	33.17
6/19/94	370.00	910.00	1,280.00	41.00	9.02	22.20	31.22
6/20/94	370.00	1,000.00	1,370.00	41.00	9.02	24.39	33.41
6/21/94	440.00	1,000.00	1,440.00	41.00	10.73	24.39	35.12
6/22/94	420.00	900.00	1,320.00	41.00	10.24	21.95	32.20
6/23/94	400.00	980.00	1,380.00	41.00	9.76	23.90	33.66
6/24/94	440.00	1,040.00	1,480.00	40.00	11.00	26.00	37.00
6/25/94	400.00	980.00	1,380.00	40.00	10.00	24.50	34.50
6/26/94	360.00	910.00	1,270.00	40.00	9.00	22.75	31.75
6/27/94	380.00	930.00	1,310.00	40.00	9.50	23.25	32.75
6/28/94	360.00	870.00	1,230.00	40.00	9.00	21.75	30.75
6/29/94	380.00	910.00	1,290.00	40.00	9.50	22.75	32.25
6/30/94	380.00	930.00	1,310.00	40.00	9.50	23.25	32.75
7/1/94	350.00	890.00	1,240.00	40.00	8.75	22.25	31.00
7/2/94	360.00	1,100.00	1,460.00	40.00	9.00	27.50	36.50
7/3/94	280.00	860.00	1,140.00	40.00	7.00	21.50	28.50
7/4/94	420.00	990.00	1,410.00	40.00	10.50	24.75	35.25
7/5/94	420.00	1,070.00	1,490.00	40.00	10.50	26.75	37.25
7/6/94	340.00	960.00	1,300.00	40.00	8.50	24.00	32.50
7/7/94	420.00	1,000.00	1,420.00	40.00	10.50	25.00	35.50
7/8/94	400.00	900.00	1,300.00	42.00	9.52	21.43	30.95
7/9/94	400.00	1,020.00	1,420.00	42.00	9.52	24.29	33.81
7/10/94	390.00	980.00	1,370.00	42.00	9.29	23.33	32.62
7/11/94	430.00	1,280.00	1,710.00	42.00	10.24	30.48	40.71
7/12/94	390.00	1,070.00	1,460.00	43.00	9.07	24.88	33.95
7/13/94	390.00	930.00	1,320.00	43.00	9.07	21.63	30.70
7/14/94	320.00	930.00	1,250.00	43.00	7.44	21.63	29.07
7/15/94	410.00	1,100.00	1,510.00	43.00	9.53	25.58	35.12

Water Consumption
on the Lonnie Nelson Farm

7/16/94	400.00	1,090.00	1,490.00	43.00	9.30	25.35	34.65
7/17/94	410.00	1,160.00	1,570.00	43.00	9.53	26.98	36.51
7/18/94	380.00	1,030.00	1,410.00	43.00	8.84	23.95	32.79
7/19/94	430.00	1,070.00	1,500.00	43.00	10.00	24.88	34.88
7/20/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7/21/94	420.00	1,060.00	1,480.00	43.00	9.77	24.65	34.42
7/22/94	450.00	1,170.00	1,620.00	43.00	10.47	27.21	37.67
7/23/94	460.00	1,200.00	1,660.00	43.00	10.70	27.91	38.60
7/24/94	460.00	1,210.00	1,670.00	43.00	10.70	28.14	38.84
7/25/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7/26/94	420.00	1,120.00	1,540.00	44.00	9.55	25.45	35.00
7/27/94	380.00	1,070.00	1,450.00	44.00	8.64	24.32	32.95
7/28/94	400.00	1,060.00	1,460.00	44.00	9.09	24.09	33.18
7/29/94	460.00	1,200.00	1,660.00	44.00	10.45	27.27	37.73
7/30/94	480.00	1,170.00	1,650.00	44.00	10.91	26.59	37.50
7/31/94	400.00	1,140.00	1,540.00	44.00	9.09	25.91	35.00
8/1/94	430.00	1,180.00	1,610.00	44.00	9.77	26.82	36.59
8/2/94	390.00	1,150.00	1,540.00	44.00	8.86	26.14	35.00
8/3/94	420.00	1,080.00	1,500.00	43.00	9.77	25.12	34.88
8/4/94	450.00	1,240.00	1,690.00	43.00	10.47	28.84	39.30
8/5/94	280.00	1,220.00	1,500.00	43.00	6.51	28.37	34.88
8/6/94	330.00	1,190.00	1,520.00	43.00	7.67	27.67	35.35
8/7/94	320.00	990.00	1,310.00	43.00	7.44	23.02	30.47
8/8/94	320.00	1,090.00	1,410.00	43.00	7.44	25.35	32.79
8/9/94	310.00	1,040.00	1,350.00	43.00	7.21	24.19	31.40
8/10/94	300.00	1,040.00	1,340.00	43.00	6.98	24.19	31.16
8/11/94	320.00	1,090.00	1,410.00	43.00	7.44	25.35	32.79
8/12/94	340.00	1,110.00	1,450.00	43.00	7.91	25.81	33.72
8/13/94	350.00	1,070.00	1,420.00	43.00	8.14	24.88	33.02
8/14/94	350.00	1,140.00	1,490.00	43.00	8.14	26.51	34.65
8/15/94	300.00	1,140.00	1,440.00	43.00	6.98	26.51	33.49
8/16/94	370.00	1,210.00	1,580.00	43.00	8.60	28.14	36.74
8/17/94	360.00	1,160.00	1,520.00	43.00	8.37	26.98	35.35
8/18/94	450.00	1,170.00	1,620.00	43.00	10.47	27.21	37.67
8/19/94	360.00	960.00	1,320.00	43.00	8.37	22.33	30.70
8/20/94	460.00	1,130.00	1,590.00	43.00	10.70	26.28	36.98
8/21/94	380.00	1,150.00	1,530.00	43.00	8.84	26.74	35.58
8/22/94	430.00	1,070.00	1,500.00	43.00	10.00	24.88	34.88
8/23/94	490.00	1,050.00	1,540.00	43.00	11.40	24.42	35.81
8/24/94	450.00	1,120.00	1,570.00	43.00	10.47	26.05	36.51
8/25/94	420.00	980.00	1,400.00	43.00	9.77	22.79	32.56
8/26/94	460.00	1,090.00	1,550.00	43.00	10.70	25.35	36.05
8/27/94	450.00	970.00	1,420.00	43.00	10.47	22.56	33.02
8/28/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8/29/94	420.00	1,010.00	1,430.00	43.00	9.77	23.49	33.26
8/30/94	420.00	870.00	1,290.00	43.00	9.77	20.23	30.00
8/31/94	420.00	960.00	1,380.00	43.00	9.77	22.33	32.09
9/1/94	360.00	970.00	1,330.00	43.00	8.37	22.56	30.93
9/2/94	390.00	870.00	1,260.00	43.00	9.07	20.23	29.30
9/3/94	320.00	840.00	1,160.00	43.00	7.44	19.53	26.98
9/4/94	450.00	860.00	1,310.00	43.00	10.47	20.00	30.47

Water Consumption
on the Lonnie Nelson Farm

9/5/94	440.00	980.00	1,420.00	43.00	10.23	22.79	33.02
9/6/94	360.00	950.00	1,310.00	43.00	8.37	22.09	30.47
9/7/94	410.00	1,100.00	1,510.00	43.00	9.53	25.58	35.12
9/8/94	330.00	980.00	1,310.00	43.00	7.67	22.79	30.47
9/9/94	340.00	1,120.00	1,460.00	43.00	7.91	26.05	33.95
9/10/94	370.00	990.00	1,360.00	43.00	8.60	23.02	31.63
9/11/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/12/94	370.00	870.00	1,240.00	43.00	8.60	20.23	28.84
9/13/94	410.00	1,030.00	1,440.00	43.00	9.53	23.95	33.49
9/14/94	410.00	970.00	1,380.00	43.00	9.53	22.56	32.09
9/15/94	400.00	970.00	1,370.00	43.00	9.30	22.56	31.86
9/16/94	340.00	840.00	1,180.00	43.00	7.91	19.53	27.44
9/17/94	450.00	1,060.00	1,510.00	43.00	10.47	24.65	35.12
9/18/94	420.00	1,120.00	1,540.00	44.00	9.55	25.45	35.00
9/19/94	380.00	1,060.00	1,440.00	44.00	8.64	24.09	32.73
9/20/94	360.00	870.00	1,230.00	44.00	8.18	19.77	27.95
9/21/94	430.00	960.00	1,390.00	44.00	9.77	21.82	31.59
9/22/94	360.00	880.00	1,240.00	44.00	8.18	20.00	28.18
9/23/94	400.00	950.00	1,350.00	44.00	9.09	21.59	30.68
9/24/94	470.00	1,050.00	1,520.00	44.00	10.68	23.86	34.55
9/25/94	350.00	870.00	1,220.00	44.00	7.95	19.77	27.73
9/26/94	410.00	1,010.00	1,420.00	44.00	9.32	22.95	32.27
9/27/94	300.00	800.00	1,100.00	44.00	6.82	18.18	25.00
9/28/94	440.00	890.00	1,330.00	44.00	10.00	20.23	30.23
9/29/94	400.00	1,060.00	1,460.00	44.00	9.09	24.09	33.18
9/30/94	340.00	820.00	1,160.00	44.00	7.73	18.64	26.36
10/1/94	310.00	950.00	1,260.00	45.00	6.89	21.11	28.00
10/2/94	260.00	770.00	1,030.00	45.00	5.78	17.11	22.89
10/3/94	230.00	710.00	940.00	45.00	5.11	15.78	20.89
10/4/94	380.00	840.00	1,220.00	45.00	8.44	18.67	27.11
10/5/94	430.00	920.00	1,350.00	45.00	9.56	20.44	30.00
10/6/94	350.00	810.00	1,160.00	43.00	8.14	18.84	26.98
10/7/94	370.00	860.00	1,230.00	43.00	8.60	20.00	28.60
10/8/94	360.00	900.00	1,260.00	43.00	8.37	20.93	29.30
10/9/94	350.00	890.00	1,240.00	44.00	7.95	20.23	28.18
10/10/94	330.00	850.00	1,180.00	44.00	7.50	19.32	26.82
10/11/94	390.00	920.00	1,310.00	44.00	8.86	20.91	29.77
10/12/94	380.00	870.00	1,250.00	44.00	8.64	19.77	28.41
10/13/94	380.00	880.00	1,260.00	44.00	8.64	20.00	28.64
10/14/94	370.00	850.00	1,220.00	44.00	8.41	19.32	27.73
10/15/94	420.00	880.00	1,300.00	44.00	9.55	20.00	29.55
10/16/94	370.00	850.00	1,220.00	44.00	8.41	19.32	27.73
10/17/94	330.00	790.00	1,120.00	44.00	7.50	17.95	25.45
10/18/94	340.00	760.00	1,100.00	44.00	7.73	17.27	25.00
10/19/94	350.00	860.00	1,210.00	44.00	7.95	19.55	27.50
10/20/94	290.00	770.00	1,060.00	44.00	6.59	17.50	24.09
10/21/94	350.00	770.00	1,120.00	44.00	7.95	17.50	25.45
10/22/94	360.00	770.00	1,130.00	44.00	8.18	17.50	25.68
10/23/94	360.00	730.00	1,090.00	44.00	8.18	16.59	24.77
10/24/94	350.00	750.00	1,100.00	44.00	7.95	17.05	25.00
10/25/94	350.00	720.00	1,070.00	44.00	7.95	16.36	24.32

Water Consumption
on the Lonnie Nelson Farm

10/26/94	260.00	720.00	980.00	44.00	5.91	16.36	22.27
10/27/94	240.00	700.00	940.00	39.00	6.15	17.95	24.10
10/28/94	280.00	730.00	1,010.00	39.00	7.18	18.72	25.90
10/29/94	290.00	770.00	1,060.00	39.00	7.44	19.74	27.18
10/30/94	320.00	770.00	1,090.00	39.00	8.21	19.74	27.95
10/31/94	220.00	700.00	920.00	39.00	5.64	17.95	23.59
11/1/94	220.00	690.00	910.00	38.00	5.79	18.16	23.95
11/2/94	250.00	670.00	920.00	38.00	6.58	17.63	24.21
11/3/94	210.00	600.00	810.00	38.00	5.53	15.79	21.32
11/4/94	220.00	600.00	820.00	38.00	5.79	15.79	21.58
11/5/94	210.00	630.00	840.00	38.00	5.53	16.58	22.11
11/6/94	240.00	660.00	900.00	38.00	6.32	17.37	23.68
11/7/94	240.00	720.00	960.00	38.00	6.32	18.95	25.26
11/8/94	210.00	600.00	810.00	37.00	5.68	16.22	21.89
11/9/94	230.00	630.00	860.00	37.00	6.22	17.03	23.24
11/10/94	200.00	610.00	810.00	37.00	5.41	16.49	21.89
11/11/94	220.00	640.00	860.00	36.00	6.11	17.78	23.89
11/12/94	200.00	590.00	790.00	36.00	5.56	16.39	21.94
11/13/94	250.00	670.00	920.00	36.00	6.94	18.61	25.56
11/14/94	200.00	600.00	800.00	36.00	5.56	16.67	22.22
11/15/94	200.00	610.00	810.00	36.00	5.56	16.94	22.50
11/16/94	210.00	600.00	810.00	36.00	5.83	16.67	22.50
11/17/94	210.00	630.00	840.00	37.00	5.68	17.03	22.70
11/18/94	190.00	580.00	770.00	37.00	5.14	15.68	20.81
11/19/94	180.00	580.00	760.00	37.00	4.86	15.68	20.54
11/20/94	230.00	600.00	830.00	37.00	6.22	16.22	22.43
11/21/94	220.00	620.00	840.00	37.00	5.95	16.76	22.70
11/22/94	210.00	600.00	810.00	37.00	5.68	16.22	21.89
11/23/94	210.00	600.00	810.00	37.00	5.68	16.22	21.89
11/24/94	250.00	670.00	920.00	40.00	6.25	16.75	23.00
11/25/94	250.00	650.00	900.00	40.00	6.25	16.25	22.50
11/26/94	250.00	700.00	950.00	40.00	6.25	17.50	23.75
11/27/94	250.00	650.00	900.00	40.00	6.25	16.25	22.50
11/28/94	250.00	690.00	940.00	40.00	6.25	17.25	23.50
11/29/94	270.00	700.00	970.00	43.00	6.28	16.28	22.56
11/30/94	250.00	700.00	950.00	43.00	5.81	16.28	22.09
12/1/94	270.00	690.00	960.00	43.00	6.28	16.05	22.33
12/2/94	250.00	680.00	930.00	43.00	5.81	15.81	21.63
12/3/94	240.00	690.00	930.00	43.00	5.58	16.05	21.63
12/4/94	240.00	670.00	910.00	43.00	5.58	15.58	21.16
12/5/94	220.00	640.00	860.00	43.00	5.12	14.88	20.00
12/6/94	240.00	680.00	920.00	43.00	5.58	15.81	21.40
12/7/94	230.00	650.00	880.00	43.00	5.35	15.12	20.47
12/8/94	250.00	650.00	900.00	43.00	5.81	15.12	20.93
12/9/94	250.00	650.00	900.00	43.00	5.81	15.12	20.93
12/10/94	250.00	660.00	910.00	43.00	5.81	15.35	21.16
12/11/94	240.00	670.00	910.00	43.00	5.58	15.58	21.16
12/12/94	250.00	660.00	910.00	43.00	5.81	15.35	21.16
12/13/94	240.00	670.00	910.00	43.00	5.58	15.58	21.16
12/14/94	230.00	670.00	900.00	43.00	5.35	15.58	20.93
12/15/94	240.00	660.00	900.00	43.00	5.58	15.35	20.93

Water Consumption
on the Lonnie Nelson Farm

12/16/94	240.00	690.00	930.00	43.00	5.58	16.05	21.63
12/17/94	220.00	620.00	840.00	43.00	5.12	14.42	19.53
12/18/94	220.00	640.00	860.00	43.00	5.12	14.88	20.00
12/19/94	180.00	610.00	790.00	43.00	4.19	14.19	18.37
12/20/94	230.00	700.00	930.00	43.00	5.35	16.28	21.63
12/21/94	230.00	650.00	880.00	44.00	5.23	14.77	20.00
12/22/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/23/94	300.00	820.00	1,120.00	44.00	6.82	18.64	25.45
12/24/94	270.00	780.00	1,050.00	44.00	6.14	17.73	23.86
12/25/94	270.00	780.00	1,050.00	44.00	6.14	17.73	23.86
12/26/94	250.00	740.00	990.00	44.00	5.68	16.82	22.50
12/27/94	250.00	740.00	990.00	44.00	5.68	16.82	22.50
12/28/94	240.00	700.00	940.00	44.00	5.45	15.91	21.36
12/29/94	280.00	750.00	1,030.00	44.00	6.36	17.05	23.41
12/30/94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/31/94	410.00	880.00	1,290.00	44.00	9.32	20.00	29.32
1/1/95	250.00	720.00	970.00	44.00	5.68	16.36	22.05
1/2/95	230.00	710.00	940.00	44.00	5.23	16.14	21.36
1/3/95	210.00	640.00	850.00	44.00	4.77	14.55	19.32
1/4/95	240.00	710.00	950.00	44.00	5.45	16.14	21.59
1/5/95	0.00	0.00	0.00	44.00	0.00	0.00	0.00
1/6/95	260.00	730.00	990.00	44.00	5.91	16.59	22.50
1/7/95	0.00	0.00	0.00	44.00	0.00	0.00	0.00
1/8/95	240.00	730.00	970.00	44.00	5.45	16.59	22.05
1/9/95	250.00	750.00	1,000.00	44.00	5.68	17.05	22.73
1/10/95	270.00	770.00	1,040.00	44.00	6.14	17.50	23.64
1/11/95	260.00	780.00	1,040.00	44.00	5.91	17.73	23.64
1/12/95	290.00	820.00	1,110.00	44.00	6.59	18.64	25.23
1/13/95	310.00	810.00	1,120.00	44.00	7.05	18.41	25.45
1/14/95	320.00	840.00	1,160.00	44.00	7.27	19.09	26.36
1/15/95	330.00	860.00	1,190.00	44.00	7.50	19.55	27.05
1/16/95	320.00	870.00	1,190.00	44.00	7.27	19.77	27.05
1/17/95	300.00	840.00	1,140.00	44.00	6.82	19.09	25.91
1/18/95	290.00	740.00	1,030.00	44.00	6.59	16.82	23.41
1/19/95	280.00	770.00	1,050.00	44.00	6.36	17.50	23.86
1/20/95	260.00	740.00	1,000.00	44.00	5.91	16.82	22.73
1/21/95	0.00	1,270.00	1,270.00	44.00	0.00	28.86	28.86
1/22/95	250.00	740.00	990.00	44.00	5.68	16.82	22.50
1/23/95	270.00	770.00	1,040.00	44.00	6.14	17.50	23.64
1/24/95	260.00	760.00	1,020.00	44.00	5.91	17.27	23.18
1/25/95	270.00	770.00	1,040.00	44.00	6.14	17.50	23.64
1/26/95	250.00	750.00	1,000.00	44.00	5.68	17.05	22.73
1/27/95	300.00	890.00	1,190.00	44.00	6.82	20.23	27.05
1/28/95	420.00	1,070.00	1,490.00	44.00	9.55	24.32	33.86
1/29/95	400.00	1,040.00	1,440.00	44.00	9.09	23.64	32.73
1/30/95	390.00	990.00	1,380.00	44.00	8.86	22.50	31.36
1/31/95	370.00	930.00	1,300.00	45.00	8.22	20.67	28.89
2/1/95	310.00	800.00	1,110.00	45.00	6.89	17.78	24.67
2/2/95	270.00	810.00	1,080.00	45.00	6.00	18.00	24.00
2/3/95	360.00	940.00	1,300.00	45.00	8.00	20.89	28.89
2/4/95	390.00	960.00	1,350.00	45.00	8.67	21.33	30.00

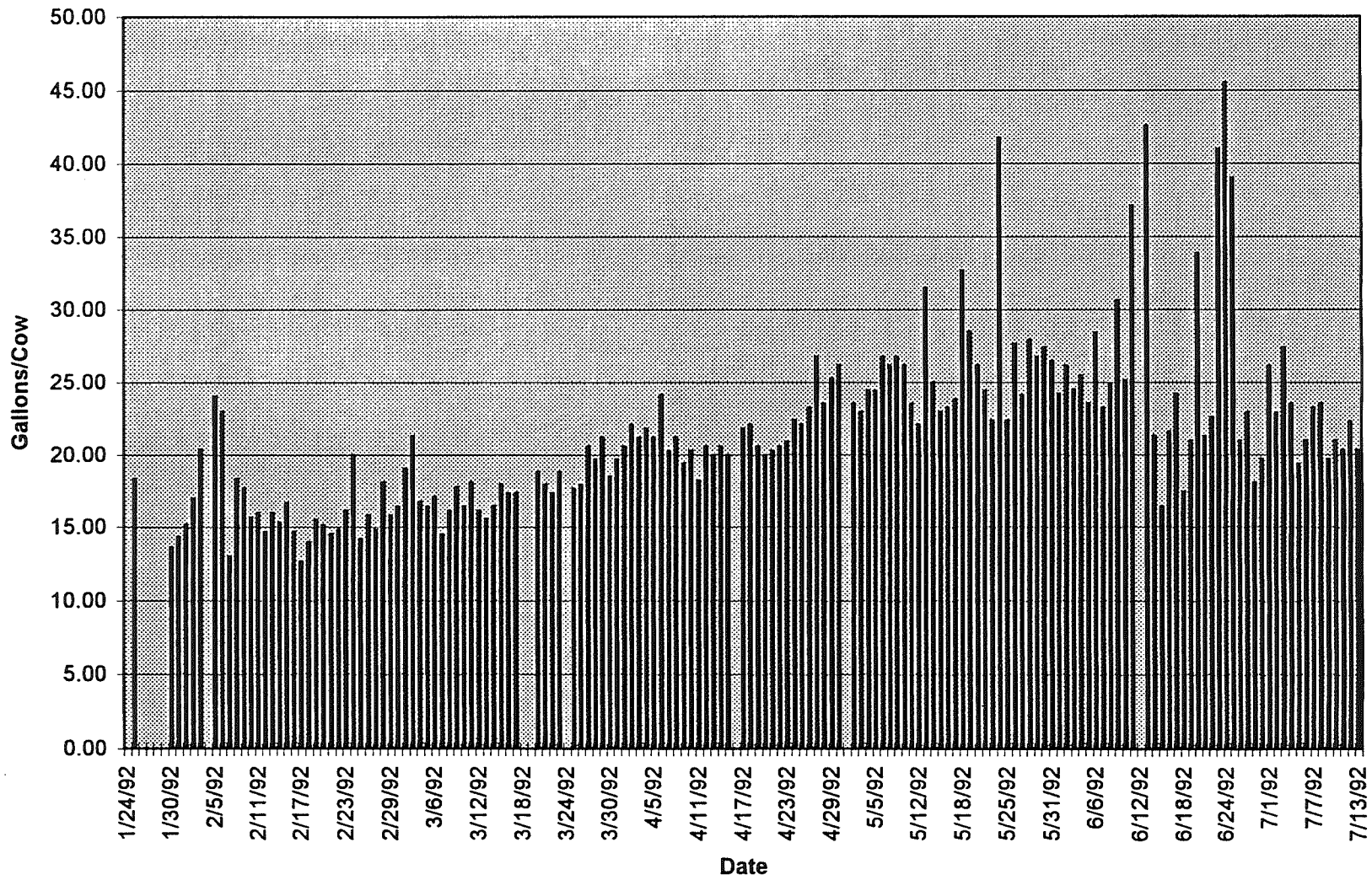
1992

Water Consumption
on the Lonnie Nelson Farm

1994

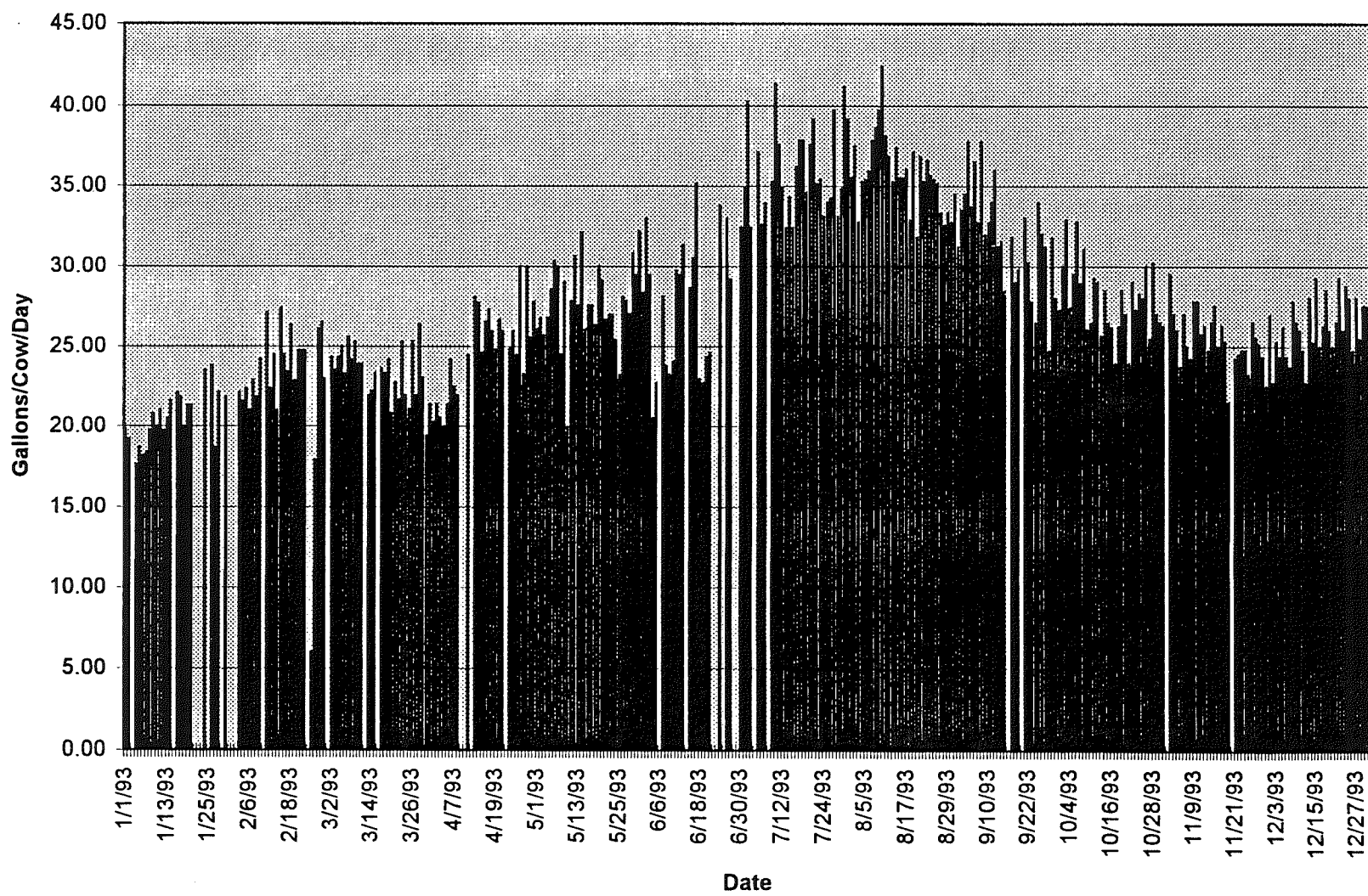
2/5/95	320.00	820.00	1,140.00	45.00	7.11	18.22	25.33
2/6/95	250.00	760.00	1,010.00	45.00	5.56	16.89	22.44
2/7/95	380.00	920.00	1,300.00	45.00	8.44	20.44	28.89
2/8/95	290.00	0.00	290.00	45.00	6.44	0.00	6.44

Water Consumption on the Nelson Farm



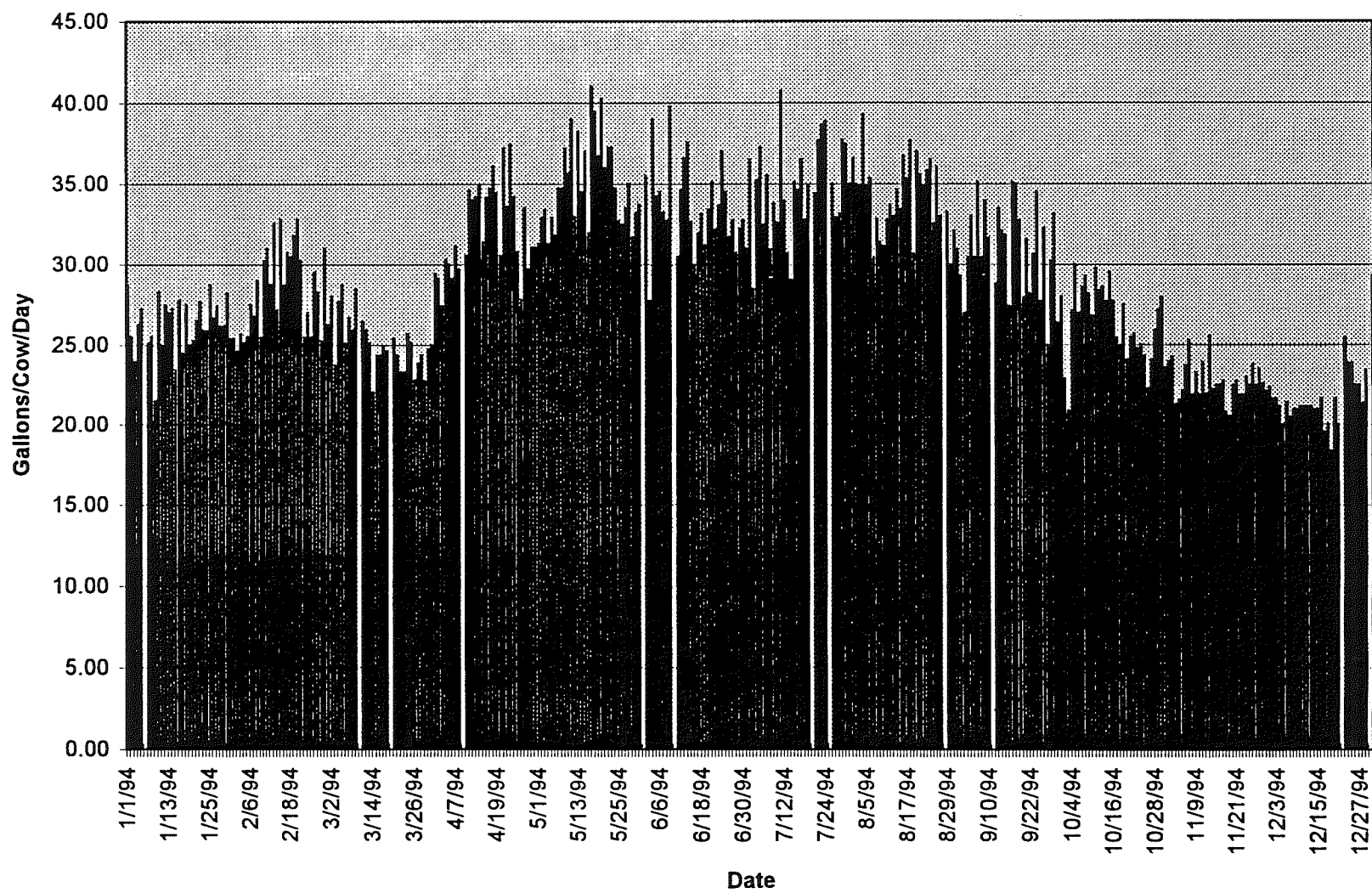
1993

Water Consumption on the Lonnie Nelson Farm

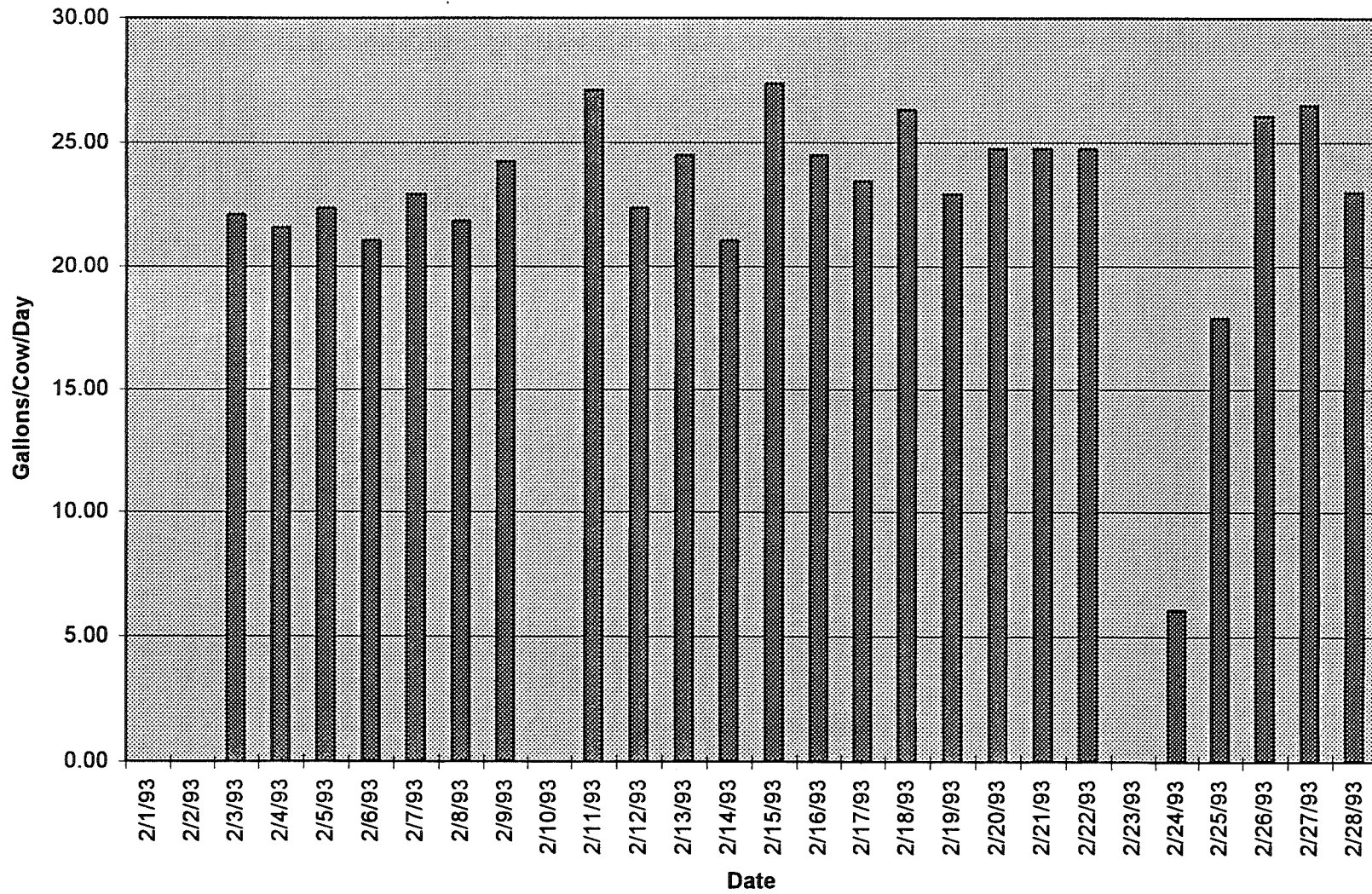


1994

Water Consumption on the Lonnie Nelson Farm

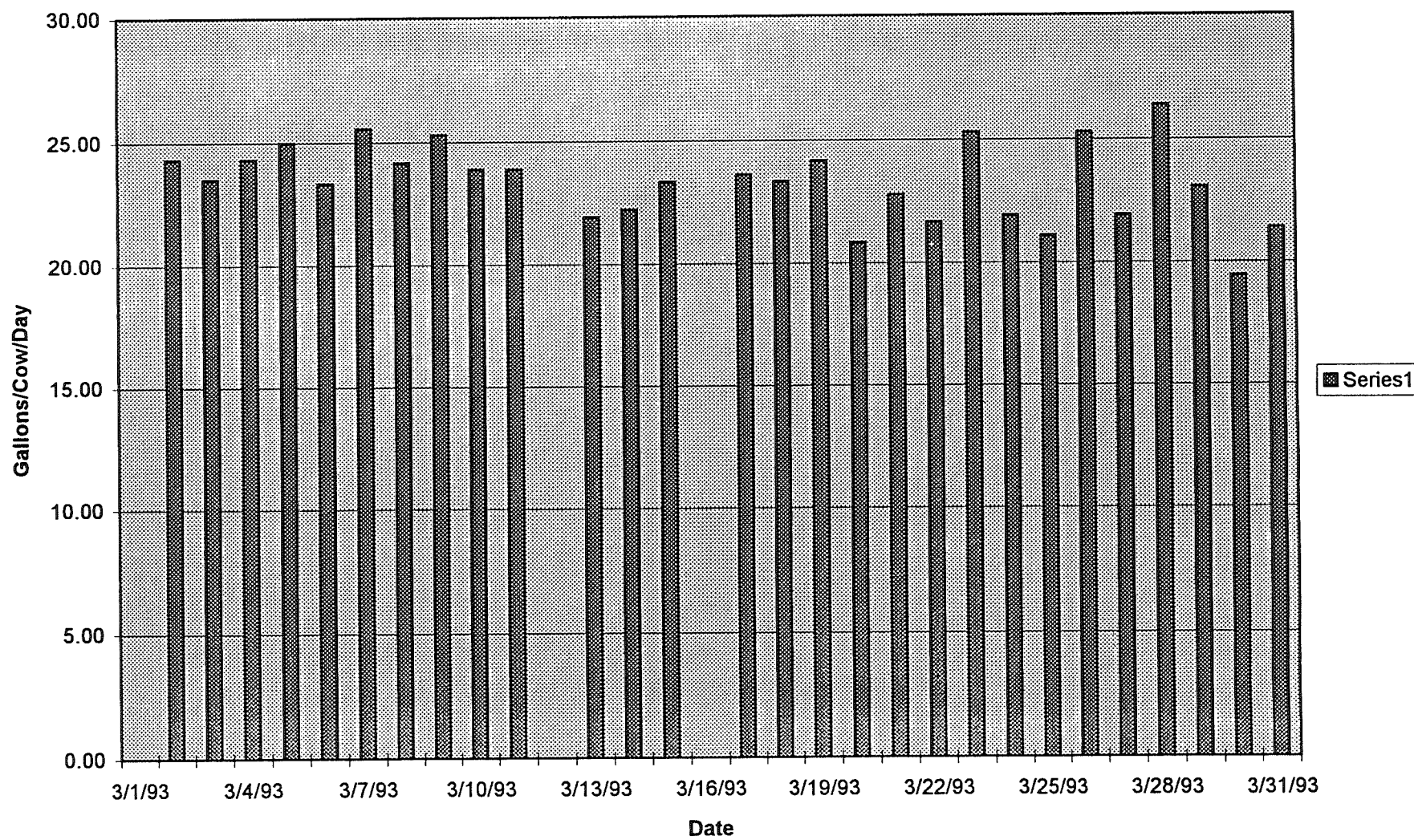


Water Consumption on the Lonnie Nelson Farm

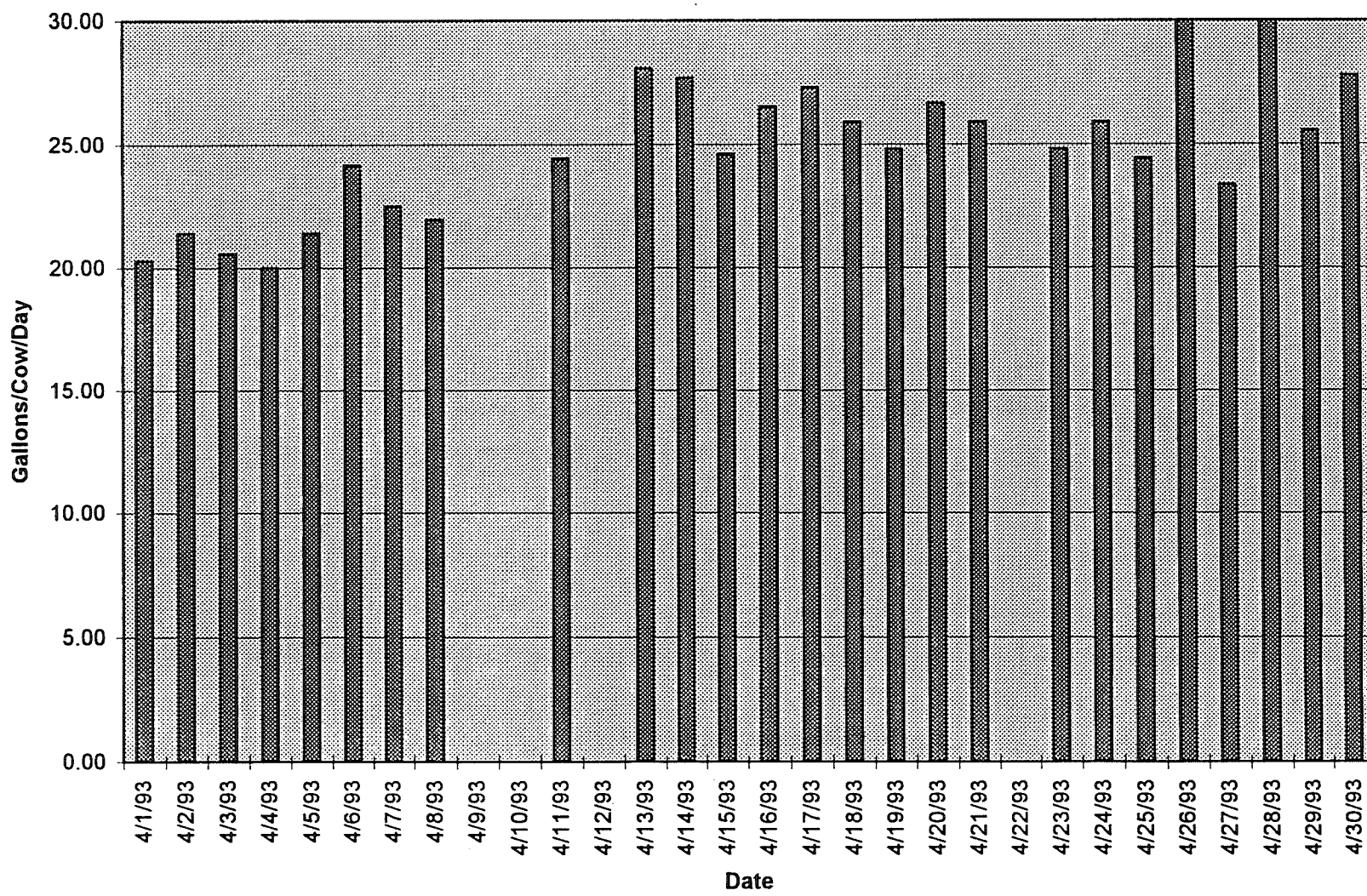


March 1993

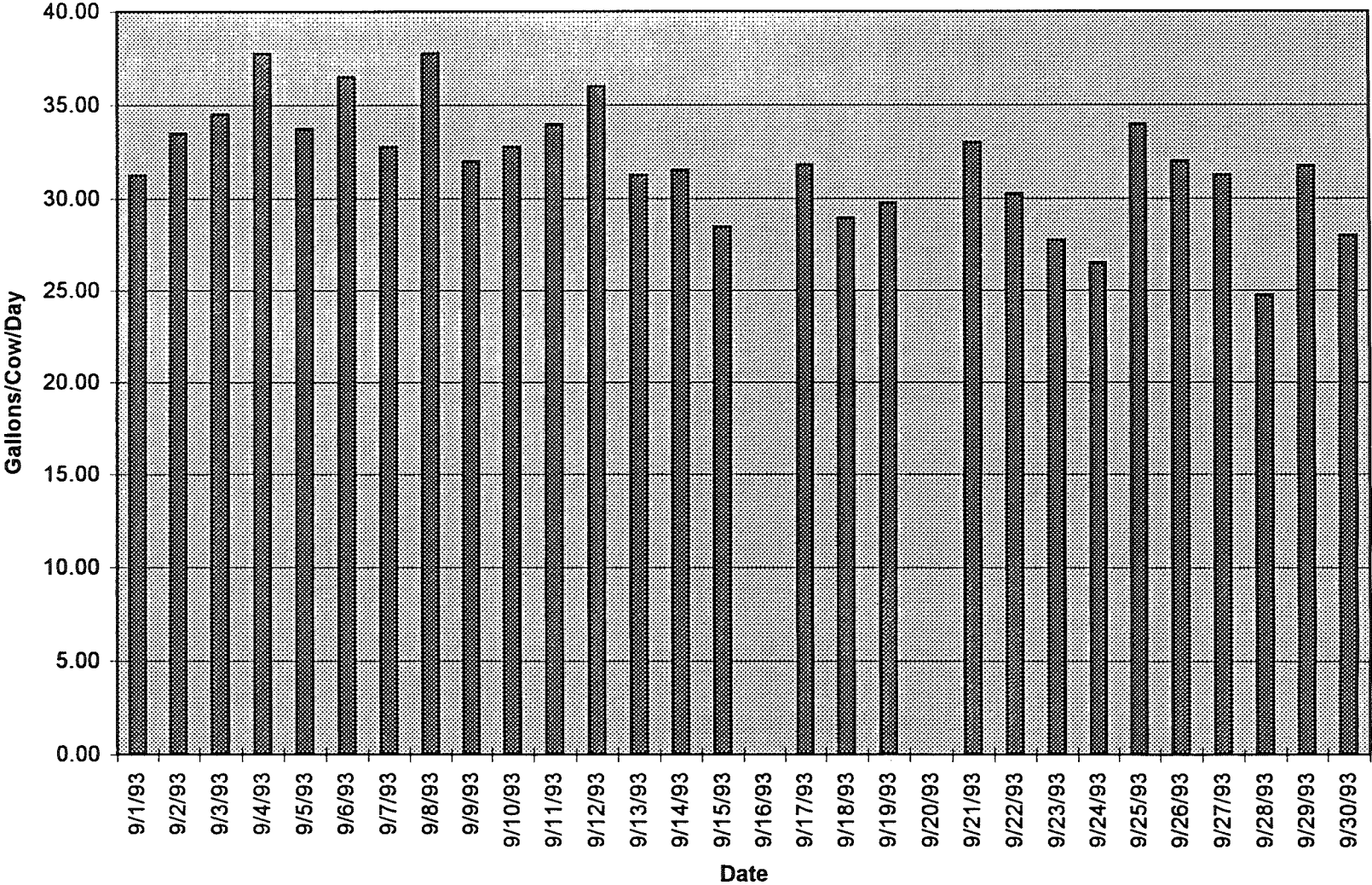
Water consumption on the Lonnie Nelson Farm



Water Consumption on the Lonnie Nelson Farm

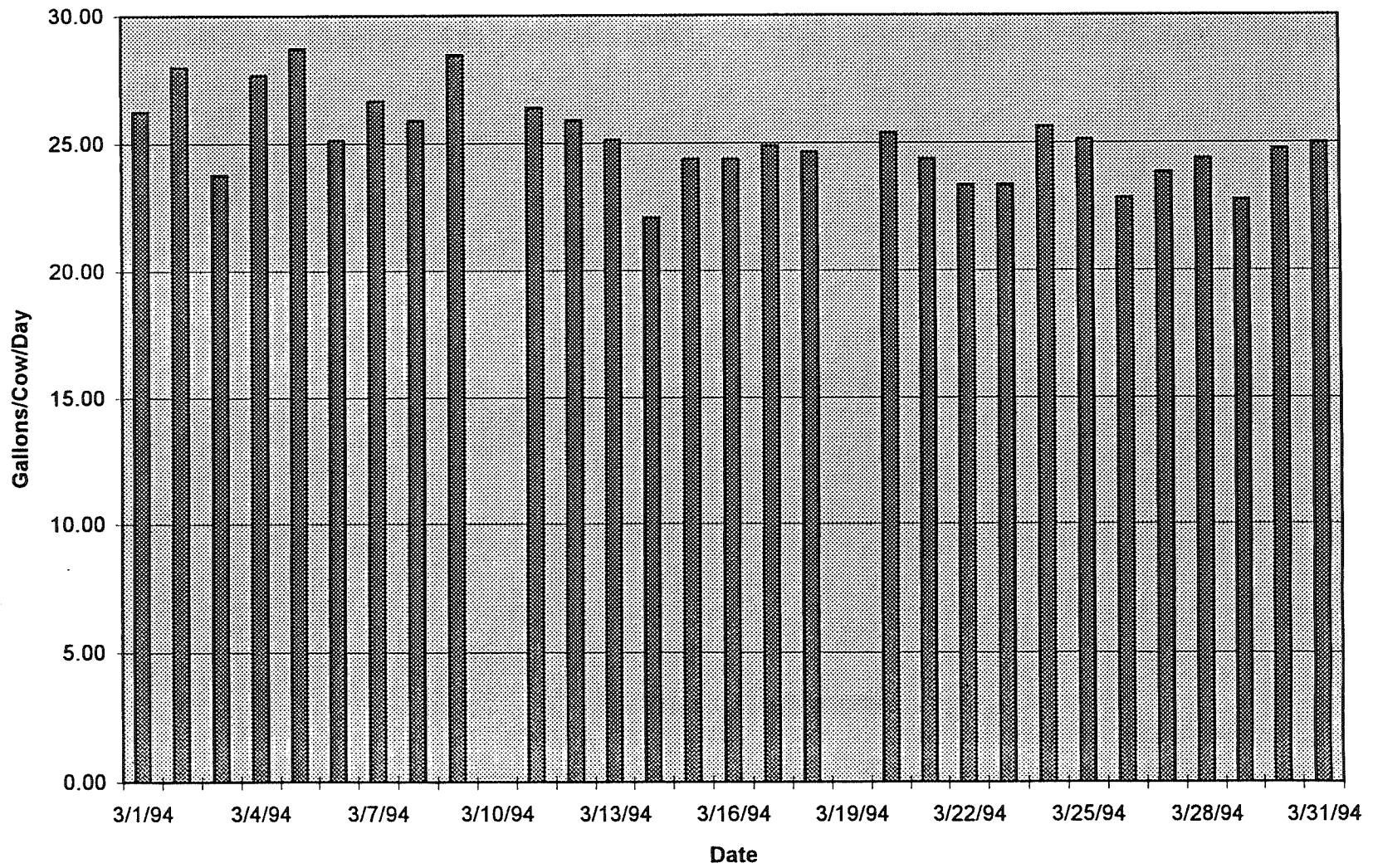


Water consumption on the Lonnie Nelson Farm



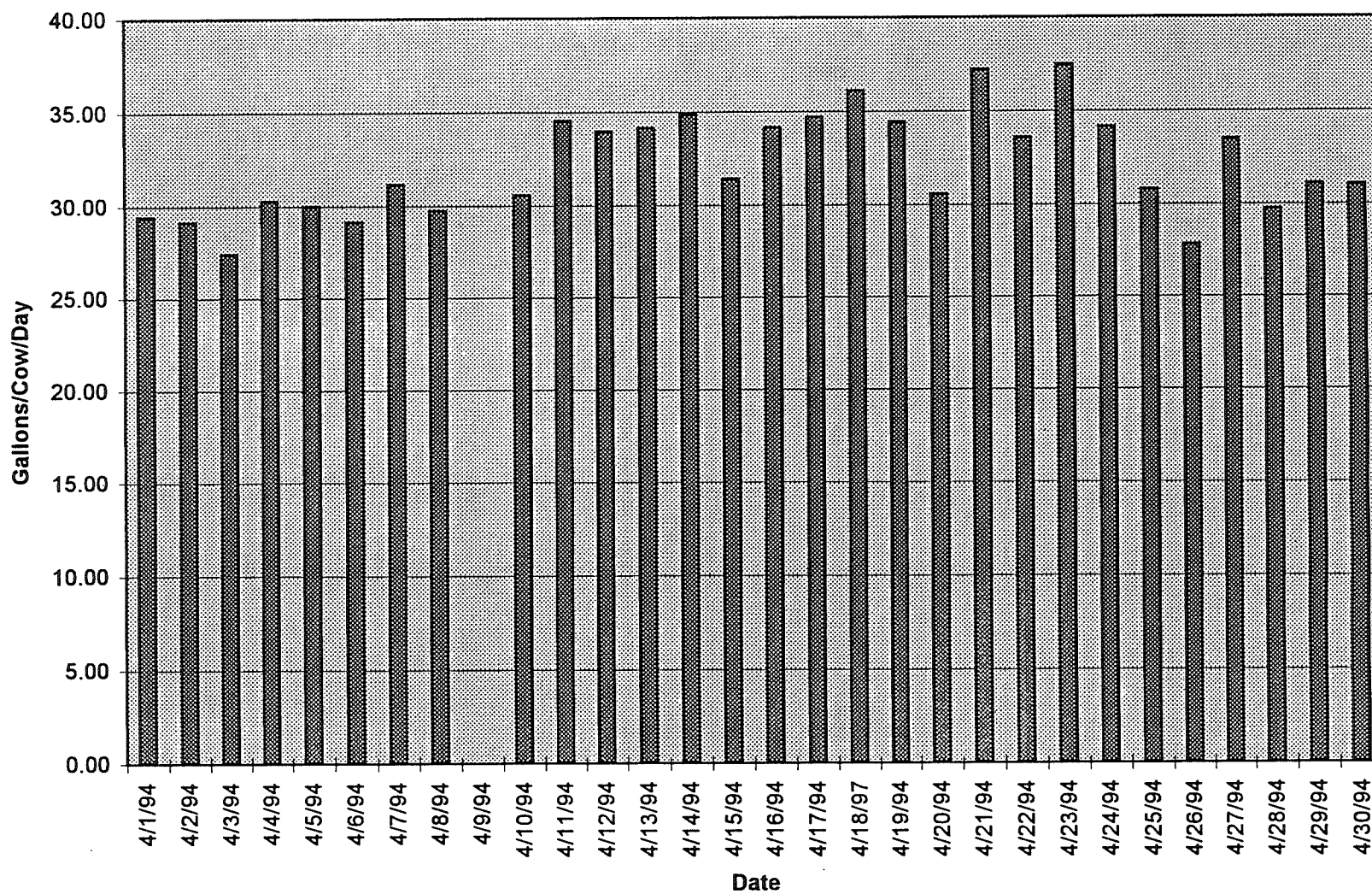
March 1994

Water consumption on the Lonnie Nelson Farm



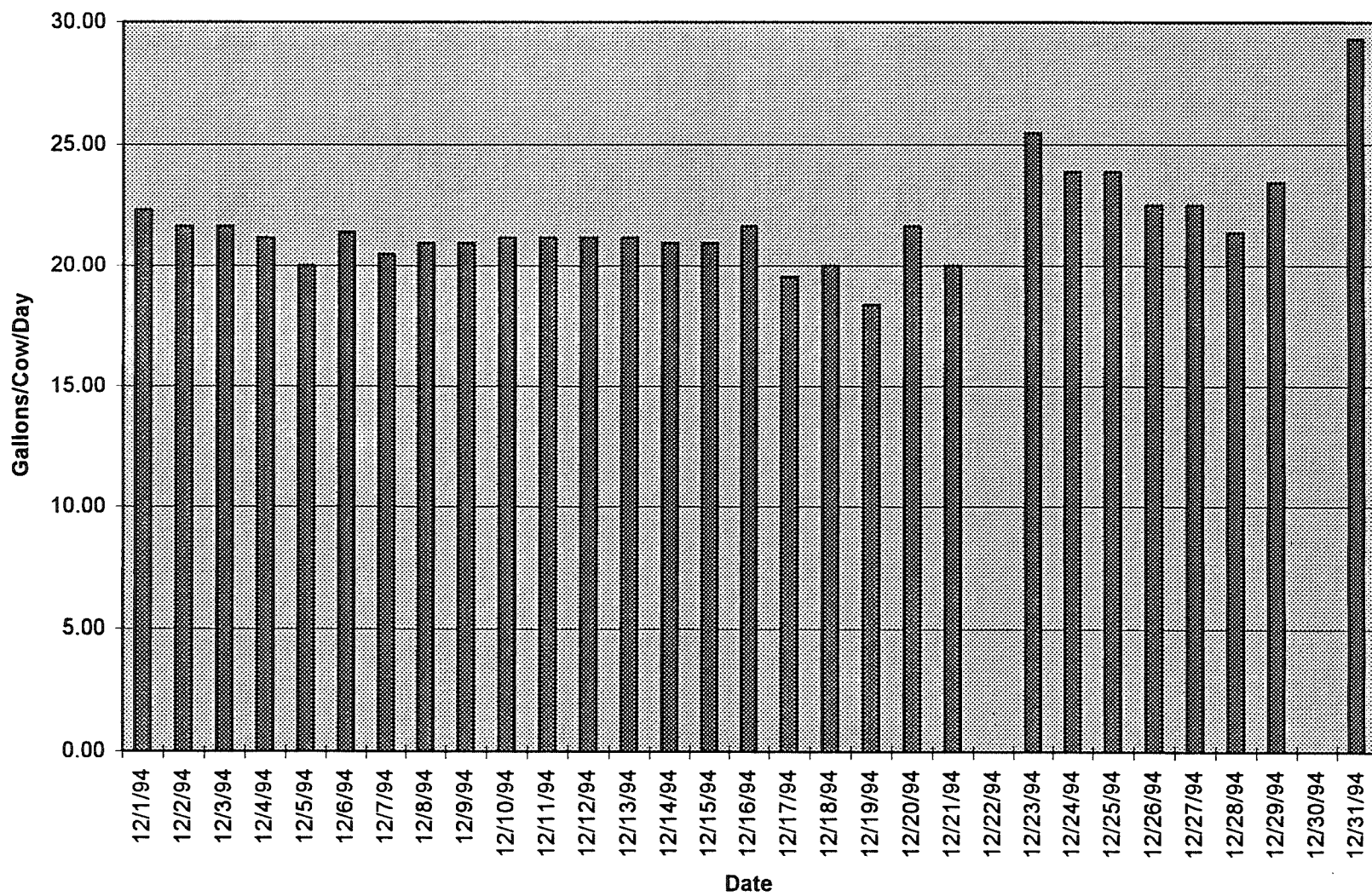
April 1994

Water consumption on the Lonnie Nelson Farm

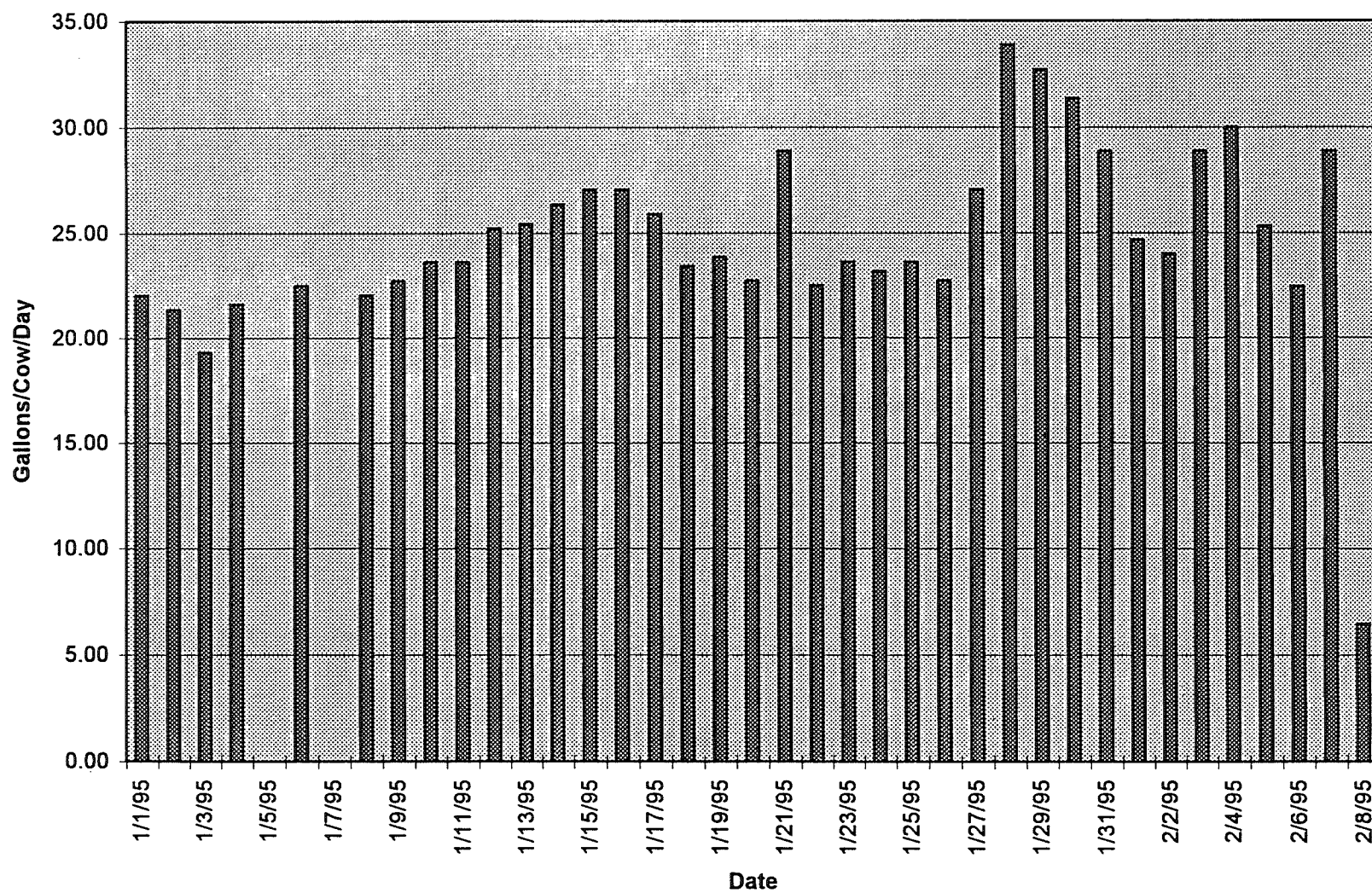


December 1994

Water Consumption on the Lonnie Nelson Farm



Water Consumption on the Nelson Farm



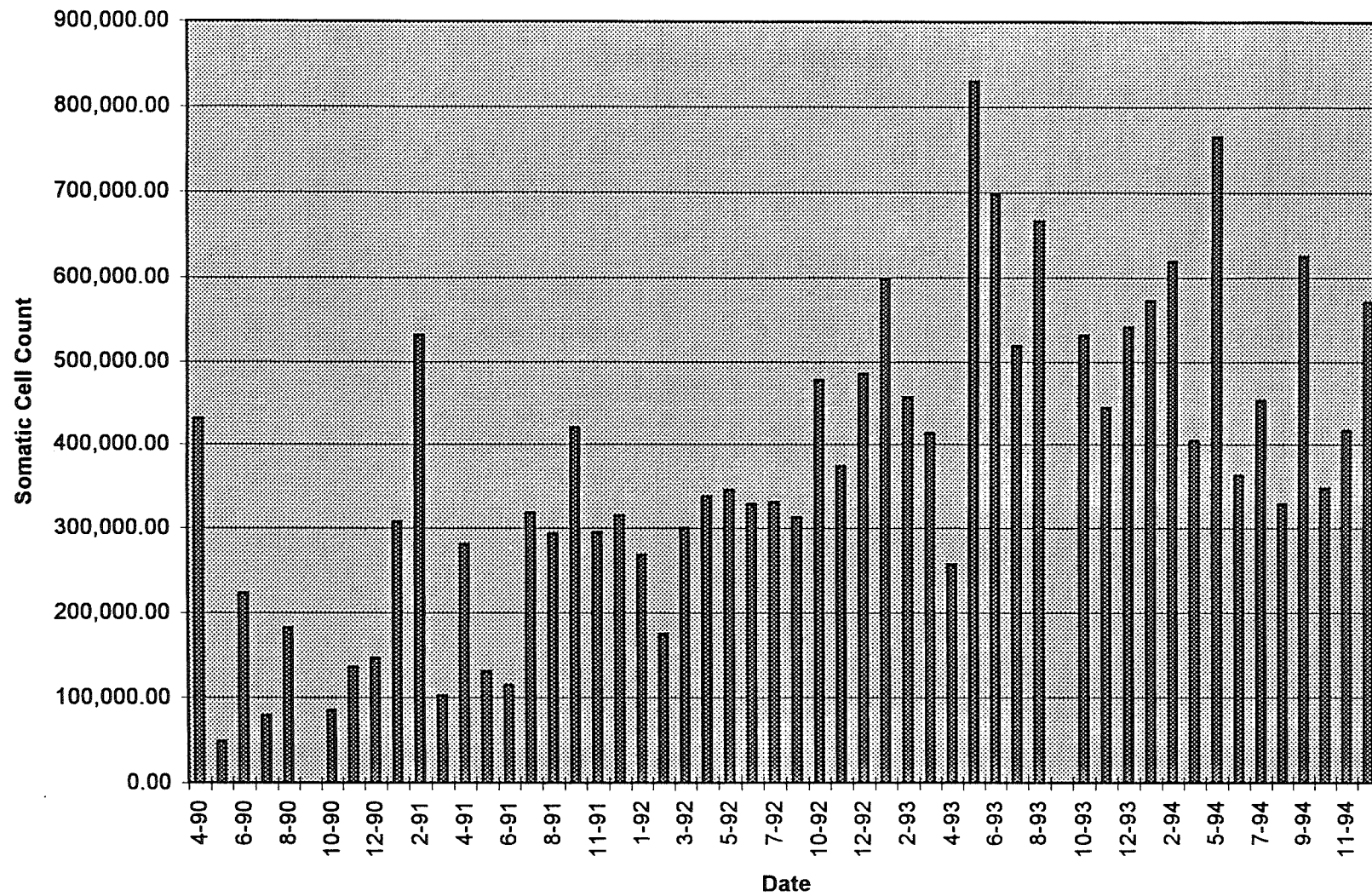
**Somatic Cell Count
on the Lonnie Nelson Farm**

Date	SCC	
4-90	431,000.00	
5-90	49,000.00	
6-90	223,000.00	
7-90	79,000.00	
8-90	182,000.00	
9-90	0.00	
10-90	85,000.00	
11-90	136,000.00	
12-90	147,000.00	
1-91	308,000.00	
2-91	531,000.00	
3-91	102,000.00	
4-91	281,000.00	
5-91	131,000.00	
6-91	115,000.00	
7-91	319,000.00	Production Starts Decreasing
8-91	294,000.00	
10-91	420,000.00	
11-91	295,000.00	
12-91	315,000.00	
1-92	268,000.00	
2-92	175,000.00	
3-92	300,000.00	
4-92	338,000.00	
5-92	346,000.00	
6-92	329,000.00	
7-92	331,000.00	
8-92	313,000.00	
10-92	478,000.00	
11-92	374,000.00	
12-92	485,000.00	
1-93	598,000.00	
2-93	457,000.00	
3-93	414,000.00	
4-93	257,000.00	
5-93	830,000.00	Grounds Hooked
6-93	698,000.00	
7-93	519,000.00	
8-93	666,000.00	
9-93	0.00	
10-93	531,000.00	
11-93	444,000.00	
12-93	541,000.00	
1-94	573,000.00	
2-94	619,000.00	
3-94	405,000.00	
5-94	765,000.00	
6-94	363,000.00	
7-94	453,000.00	

**Somatic Cell Count
on the Lonnie Nelson Farm**

8-94	329,000.00	
9-94	625,000.00	
10-94	348,000.00	
11-94	417,000.00	
12-94	571,000.00	

Somatic Cell count on the Lonnie Nelson Farm



CASE 160

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Production

Breeding problems

Health

Cows would leave 1/3 of their feed in the bunk

Bad feet

Dull hair coats

Lumpy joints

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm is a parlor-freestall system with 160 cows.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

A blocker was installed on the system--things seemed to improved until a spell of wet weather.

CASE 161

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cattle refuse to enter porter
Cattle seem nervous
Cattle lick the water
Cows seem tired
Cows tongue, feet and teats turn dark

Production

Slow milkout
Decreased milk production
Breeding problems

Health

Rapid weight loss
Low water consumption
Low feed consumption

HUMAN HEALTH

1st, 2nd, and 3rd person excessive fatigue
Burning sensation

CALVES

Poor survival rate
Unable to grow at a normal rate

PETS

Dogs demonstrated strange behaviors

GENERAL INFORMATION

FARM CHARACTERISTICS

This farm was located in a region with a high density of small lakes and ponds and obviously a high water table. There were natural gas and oil pipelines on four sides of the farm all less than one mile away. These pipelines had active cathodic protection systems installed during the time this farm was operating. The farm uses a parlor system for milking and a free stall area for holding the cows when not being milked.

ELECTRICAL EFFECTS ON FARM

Noted were:

Corrosion of metals in all areas of the farm. Even farm machinery would show rusting.

MEASUREMENTS

At all times in cow contact areas the DC voltage ranged between 0.5 and 1.0 V. A number of measurements were made in the areas occupied by the animals. The measurements were primarily DC voltages. The voltages ranged between 1.2 and 0.7 VDC. A test was done to determine the impact of the cathodic protection rectifiers. When the rectifiers were turned off there was no change in the DC voltage readings. After they had been turned off for a period of ten days all the DC voltages had decreased or increased by 10 % to 300%. Immediately after the rectifiers were turned on, all of the readings increased by approximately 5 %. There appeared to be a charging effect in the earth which reached a maximum value and only showed a change after a period of discharge.

MITIGATION

An equipotential plane was installed in the barn. The health and production of the dairy cows did not improve.

OBSERVATIONS AND CONCLUSIONS

Haylage is noted to become dark and ties up protein. Corn silage would also get dark and heat to 120 degrees F. In addition the liquid from the corn silage would have a red color while on the ground and turn brown upon taking it off the ground. Cattle were not able to eat the grass in the pasture unless it was first cut for them.

When the rectifiers were installed for cathodic protection on the pipelines, the farmer experienced the greatest onset of serious problems. In the area 8 rectifiers each delivering approximately 40 A DC to the pipelines. Initially all of the current would travel through the earth between the various parts of the pipeline system and the anodes. Later a change was made to reduce the amount of current traveling through the earth.

It was during the time the current was all traveling through the earth that the effects on the farm were especially severe. At times 1 to 5 VDC could be measured in the barn. During that time period the farmer noted water bubbling at night in a pond near the barn. In the morning the bubbling had stopped but a scum was left on the water but went away later in the day. The same effect was also noted for water standing after a rain.

After the changes were made in the cathodic protection rectifiers so that less current went through the ground the observations of the bubbling water could no longer be made. During this time period the conditions were so serious on the farm that the farmer could not continue the dairy operation.

CASE 162

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Dog has stiff joints
Dog becomes skittish at different points of property

HUMAN HEALTH

1st, 4th, 6th, and 7th person tingling or numbness in arms or legs
2nd, 3rd, 7th, 8th, 9th, and 11th person frequent headaches
1st, 7th, 9th, 10th, and 11th person frequent flu-like or cold symptoms
1st, 3rd, 4th, 7th, 9th, and 11th person vision problems (e.g. blurred or heavy eyelids) (3rd person eye irritation dryness and itchy eyes)
1st, 3rd, 6th, 9th, 10th, and 11th person problems with breathing (asthma)
1st, 2nd, 3rd, 4th, 6th, 7th, 8th, 9th, 10th, and 11th person excessive fatigue (2nd person complains of feeling tired and not knowing why when he slept well)
1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 10th, and 11th person frequent irritability
2nd, 3rd, 5th, 6th, 7th, 8th, and 10th person often feeling under stress
1st, 2nd, 4th, and 7th person weakness and pain in legs (2nd person knees)
1st, 2nd, 3rd, 4th, 6th, 7th, 8th, 9th, 10th, and 11th person forgetfulness
6th and 11th person allergies
3rd, 5th, and 9th person ears ringing (3rd person feels plugged up)
10th person unexplained nausea
2nd, 3rd, 5th, 6th, 7th, 9th, and 10th person unexplained general feeling of not being well
1st, 2nd, and 3rd person rheumatoid arthritis
6th person high incidence of malignant body tumors
3rd, 6th, 8th, and 10th person (female) feeling bloated/retaining body fluids
3rd, 6th, and 8th (female) problems with menstrual cycle (3rd and 8th person cramps)
11th person having an illness that medical professionals cannot diagnose
4th person learning disabilities, hyperactivity (away from home), small head size, birth anomalies (extra cervical ribs, problems with incontinence, imperforate anus)
5th person stenosclerosis (left ear), excessively dry skin and scalp, and unexplained stomach aches
7th person skin irritation on head, scalp, and lower extremities which no soaps or medication have cured
8th and 9th person neurological illness (8th person petit mal's)
9th person nephritic syndrome
10th person constantly stuffy nose
11th person allergies since birth, progressing to asthma, treated with asthma medication, chronic fatigue, history of unresponsive episodes, being treated for seizure disorder with anticonvulsant medication,
?neurogenic-cardiogenic disorder

GENERAL INFORMATION

This case study is not of a dairy farm but rather of a neighborhood. This neighborhood is located in close proximity to two substations, one smaller and one quite large. There is also a transmission line corridor to the North of this block. Data has been compiled from eleven individuals who have lived on this block from 9 to 35 years.

EQUIPMENT AND MACHINERY PROBLEMS

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure
Radio and TV set failure (non-lightning related)
Unexplained radio and TV interference
Noisy telephone requiring frequent service calls or having false rings

HISTORICAL BACKGROUND

MEASUREMENTS

Field along street next to substation: 0.8 mg, higher at street surface. On sidewalk: 0.4 mg, going up from 1-2 mg where water line crossed the sidewalk entering homes. There is significant current on water pipe: Amperes - at least 5, approaching homes held steady or began to increase.

Home 1: significant current on water pipe running length of home on South side living room, dining room, kitchen. Magnetic fields at floor line 7 - 10 mg at times. North side better except near pipes in bathroom going to the shower - high current. Around water pipes in basement - high. Background field throughout the home ranged 0.6 - 1 mg, appears to be a strong connection with currents in earth. Oscilloscope indicated home had significant harmonics - not quite square but not 60 Hz either. The fact that the magnetic field was higher in the home than outside implies that current moving through the home must have importance.

Home 2: Background field in home is approximately 0.6 mg. High fields: at concrete floor, floor in kitchen. Higher in laundry area - new entrance bore had large ground carrying large current. Electric current had to be in floor and ground also. High fields on North side of the house especially where resident slept as a child.

Home 3: Lowest field in living room, as low as 0.3 mg. Along the West side water line runs the width of the house. The kitchen is especially bad - 4 mg and higher at floor level. In Southwest bedroom, lower level fields were higher ranging from 1 - 2 mg and higher where water pipes are closer. Apparent correlation between fields where children slept and location where they have problems. Again complex ground currents added to fields present.

Home 4: Significant interaction between magnetic fields from ground currents and from substation. The current is on the water line: goes out on conduit and grounds of cables from fuse box and to fuse box - adds significantly to fields in a number of locations in home. Again wherever children slept with problems, fields highest on mother's bed 3 - 4 mg.

Home 5: 2 - 4 mg in home. Affected mostly by 65 KV line running across line corridor. Very little current on water pipes. Signal on neutral very complex. Fields drop off very slowly. Fields as high in basement as upstairs.

OBSERVATIONS AND CONCLUSIONS

There are serious problems in human well being among the people that live on this block. The symptoms and effects are characteristic of typical stray voltage problems.

Traveling through the earth in return to the substations electricity is finding its way onto water lines and into the homes of these people. Having 5 or more Amperes of current traveling on water pipes that go into these homes is dangerous and unacceptable. Substations should not be built in such close proximity to homes.

CASE 163

ANIMAL AND HUMAN WELL BEING AS DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows all lay down together occasionally
Heifers have difficulty adjusting to stalls

Production

Fluctuates
Cattle leak milk

Health

Deteriorates
10 to 15% of first calf heifers die

HUMAN HEALTH

Chronic soreness in feet, legs, hips, and lower back
Feet and legs are especially painful

MEASUREMENTS

Maximum primary neutral to earth voltage: 10 VAC
Minimum primary neutral to earth voltage: .3 VAC
Maximum secondary neutral to earth voltage: 10 VAC
Minimum secondary neutral to earth voltage: .3 VAC
Cow contact voltage between stalls and water lines: 10 VAC

MITIGATION

The farm has a neutral isolator.

OBSERVATIONS

The problems with the cows seem to be cyclical in nature.

CASE 164

ANIMAL AND HUMAN WELL BEING AS DOCUMENTED BY DAIRY OPERATOR

CATTLE

Production

Problems during first lactation

Health

Leg problems

MEASUREMENTS

Maximum primary neutral to earth voltage: 2.5 VAC

ELECTRICAL CHANGES AND CORRELATING EFFECTS

After the neutral isolator was installed cattle health was much improved. There were fewer leg problems and especially fewer problems with first lactation or newly purchased animals.

MITIGATION

The farm has a neutral isolator.

CASE 165

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Breedback difficulties
Cow production peaking early and not holding
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions
Poor milk production
Breedback difficulties
High somatic cell counts

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Heifers and cows have trouble getting up (legs seem numb)
Leukemia/anemia

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person frequent flu-like or cold symptoms
1st and 2nd person ears ringing
1st person neurological illness (e.g. Multiple Sclerosis)
1st person unexplained nausea
1st person rheumatoid arthritis

GENERAL INFORMATION

FARM CHARACTERISTICS

This dairy farm is located 1/2 mile from the 400 KVDC electrical transmission line.

ELECTRICAL EFFECTS ON THE FARM

Unusually high rate of battery failure

CASE 166

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

High veterinarian bills

Heifers and cows have trouble getting up (legs seem numb)

CALVES

Calves having poor survival rate

HUMAN HEALTH

1st person tingling or numbness in arms or legs

2nd and 3rd person frequent headaches

2nd person frequent flu-like or cold symptoms

2nd person vision problems (e.g. blurred or heavy eyelids)

2nd person problems with breathing

2nd person excessive fatigue

2nd person frequent irritability

1st person often feeling under stress

2nd person weakness and pain in legs

1st and 2nd person forgetfulness

2nd person allergies

2nd person pressure behind the eyes

2nd person unexplained general feeling of not being well

1st and 2nd person rheumatoid arthritis

2nd person feeling bloated/retaining body fluids

1st person and 2nd person having an illness that medical professionals cannot diagnose

1st and 2nd person stomach problems

2nd person has been treated for problem with breathing and rheumatoid arthritis

GENERAL INFORMATION

FARM CHARACTERISTICS

ELECTRICAL EFFECTS ON THE FARM

Radio and TV set failure (non-lightening related)
Occasional shocks from water lines and faucets
Noisy telephone requiring frequent service calls or having false rings

HISTORICAL BACKGROUND

There is an isolation transformer on the property. This farmer has lived on the same dairy farm for 50 years. They have now been forced to quit the dairy business due to problems with stray voltage.

MITIGATION

This farm has an isolation transformer.

CASE 167

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.
Poor water consumption

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions
Excessive teeth found in feeders and feedbunk

CALVES

Calves unable to grow at normal rate
Calves having poor survival rate
Calves having swollen joints

PETS

Cats sickly with rough, dull and shaggy coats

HUMAN HEALTH

1st person tingling or numbness in arms or legs
2nd person frequent headaches
1st person frequent flu-like or cold symptoms

1st and 2nd person vision problems (e.g., blurred or heavy eyelids)
1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st and 2nd person forgetfulness
1st person ears ringing
1st and 2nd person pressure behind the eyes
1st person rheumatoid arthritis
1st and 2nd person unexplained general feeling of not being well
2nd person feeling bloated/retaining body fluids
2nd person problems with menstrual cycle
Infertility

GENERAL INFORMATION

FARM CHARACTERISTICS

This dairy farm is located 2 miles south of a 400kv transmission line. There is also a gas or oil pipeline 3 miles north of the farm. Both run parallel with the farm.

ELECTRICAL EFFECTS ON FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failures
Increasing motor burnouts
Occasional shocks from water lines and faucets
Accelerated corrosion of well casings or other buried pipes
Noisy telephone requiring frequent service calls or having false rings

HISTORICAL BACKGROUND

ELECTRICAL CHANGES AND CORRELATING EFFECTS

In 1982, an isolation transformer was installed. In the year following, milk production went up 100,000 pounds. Since that time, there have been 5 periods of stray voltage. The last period was in 1992.

MITIGATION

This farm is isolated.

CASE 168

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions
Cow production peaking early and not holding
High somatic cell counts

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
Inability to maintain weight in cold weather
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Inflamed sphincter valve

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person frequent irritability
1st person often feeling under stress
1st person feeling bloated/retaining body fluids
1st person problems with menstrual cycle
1st person unexplained feeling of not being well
1st person forgetfulness

GENERAL INFORMATION

ELECTRICAL EFFECTS ON THE FARM

Notes were:

Unexplained fluctuations in electric bills

ELECTRICAL CHANGES AND CORRELATING EFFECTS

An isolation device was installed on the neutral system of this dairy farm. After this installation, nearly all problems decreased. Where 15-20 cows had been exhibiting strange behavior before, now only 5 do so. Income is up by 50%, and milk production increased 2000 pounds.

MITIGATION

This farm is isolated.

CASE 169

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Cows biting drinking cups, slopping in cups, won't put nose in water

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Inability to maintain weight in cold weather

Inflamed sphincter valve (even among un milked heifers)

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

CALVES

PETS

HUMAN HEALTH

1st, person tingling or numbness in arms or legs

1st and 2nd person frequent headaches

1st and 2nd person excessive fatigue

1st and 2nd person frequent irritability

1st and 2nd person often feeling under stress

1st person weakness and pain in legs

1st and 2nd person forgetfulness

1st person allergies

1st person ears ringing

2nd person pressure behind the eyes

1st person unexplained general feeling of not being well

2nd person (female) feeling bloated/retaining body fluids
1st person occurrence of heart related ailments

GENERAL INFORMATION

FARM CHARACTERISTICS

There are electrical transmission lines 2 1/2 to 3 miles near the living and work area. There is an isolation transformer on the property.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusual failure rate for incandescent bulbs
Unusually high rate of battery failures
Radio and TV failures not related to lightening storms
Occasional shocks from water lines and faucets -- has been corrected
Electricity flickers

HISTORICAL BACKGROUND

This farm family has lived on this farm for years. They have an isolation transformer and have been checked for stray voltage 2 times -- most recently about 2 years ago.

They have experienced stray voltage both on this farm and also where they use to live in 1983-1986.

MEASUREMENTS

The farmer has recorded voltages of 5 VAC and spikes up to 7 volts, but the computer tests did not show levels for either N-E voltages nor cow contact voltages which the utility thinks can cause stray voltage problems.

MITIGATION

This farm is isolated.

CASE 171

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.
Some cattle refused to eat silage

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inflamed sphincter valve (even among un milked heifers)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm is located 7 miles North of an electrical transmission line.

ELECTRICAL PROBLEMS ON THE FARM

Unexplained fluctuations in electrical bills

HISTORICAL BACKGROUND

The farmer has lived on this farm since birth and is the age group of the 60's.

The farmer sold his herd in 1989; however, at that time the problems were seemingly improving as an isolator had been installed. The utility company could find no fault in the farm's machinery or wiring, so whatever stray voltage was present was coming from the neutral line.

Many of the farmer's neighbors are experiencing the same problems with their cattle.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

An isolation device was installed after a neighbor suggested that the problems could be from stray voltage. The cattle seemed to improve at this point, but the farmer soon sold his herd so the long term effects could not be documented.

MITIGATION

The farm has been isolated.

OBSERVATIONS

Symptoms were observed throughout the 80's. (A neighbor suggested he look into stray voltage.)

CASE 172

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls (some of this)
Cattle dancing back and forth in stalls (some of this)
Cattle kicking milkers off (some times)
Cattle pressing their noses against stall pipes, water cups or cement curbs. (Some times)

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions (a few spontaneous abortions every year)

Health

Multiple or recurring mastitis (not responding to treatment)
Inability to maintain weight in cold weather
Constant lice problems (but never problems with hair coat
Stress signs on the hoofs (excessive growth)--some cows

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person vision problems (e.g., **blurred** or heavy eyelids)
1st person excessive fatigue (the entire family sleeps a lot)
1st person often feeling under stress (yes, but some stress is normal)
1st person weakness and **pain in legs**
1st person ears ringing
3rd person frequent flu-like or cold symptoms

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm does not have a major transmission line nor a natural gas or oil pipe line nearby. It does not have an electrical isolation device either.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)--when one lamp burns out, the farmer buys a new lamp because he is sure the rest of the lamps will burn out within the next two weeks

HISTORICAL BACKGROUND

The farmer has lived on the farm for 16 years and 6 months. He is in the age group of the 60's.

The farmer describes his story in the following paragraphs:

My experience with stray voltage started as soon as I started milking cows in this milking parlor more than ten years ago. The SCC in our milk was always high being over 70,000. In the fall when the grain dryers were running the cows would not milk out. We have milked about twelve cows over the years and we would have one or two abortions every year. In August of 1991 we got a four inch rain. The ridge over the barn was open and the parlor was right under that ridge. The parlor, walls and ceiling of the parlor were saturated with water. The cows became reluctant to enter the parlor. The SCC went over 1,000,000. The field manager came over with a volt meter. I was surprised to learn that the walls, ceiling, doors, poles, gate and sliding door track had from one to one and one-half volts to almost four volts of stray voltage on them. The field manager and I noticed that when the barn lights were out that the stray voltage was much less. That evening I milked without the lights. The milkout was great that night and I became a believer in stray voltage. I got to thinking that this stray voltage could be grounded out like an electric fence, so that is hat I did. I stapled bare, copper wire to the walls, poles, and any place that the meter would read voltage. We fastened bare, copper wire to the sliding door tracks and steel gates and grounded them. None of this wire is connected the utility ground.

We didn't treat any of the cows for mastitis, but we did dry teat, we cultured them and then we used whatever the vet suggested to treat them. The SCC started to decline and by July, 1992 we had a few milk plants SCC readings of under 100,00. Now when the SCC is high there is a reason, such as muddy pastures or frostbite on the teat ends. There haven't been any unexplained abortions either.

I asked the utility company to check my place for stray voltage and they hired an independent contractor to come out and check the place. This contractor assured me that the stray voltage would not cause a fire. He also told me to leave the bare, copper wire on the walls, poles, ceiling and door tracks. He told me not to change anything. He also suggested to increase the size of the ground wire to the entry pole.

MITIGATION

In the winter of 1991 the farmer wrapped and stapled bare copper wire to walls, poles, doors, etc., and connected to a ground rod separate from the neutral grounds.

The DHIA rolling herd average was 12,279 on 14 cows on 12/04/91 and it has increased to 14,352 on 19 cows on 12/05/92. The year 1992 was also their highest year for milk sales.

OBSERVATIONS

The symptoms have been observed for 127 months.

CASE 173

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

Veterinary bills would have been high had they had enough money to call the veterinarian

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person frequent headaches
1st person frequent flu-like or cold symptoms
1st person vision problems (e.g., blurred or heavy eyelids)
1st person problems with breathing
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
2nd person allergies
1st person ears ringing
1st person unexplained nausea
1st person unexplained general feeling of not being well
1st and 2nd person rheumatoid arthritis
1st person high incidence of non-malignant body tumors
Boy get bloody noses often

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a major electrical transmission line 300 yards from the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Occasional shocks from water lines and faucets

HISTORICAL BACKGROUND

The farmer has lived on the farm for 16 years and is in the 50's age group.

They have lost 40 head of cow's and heifers in 8 years. The cows do not come into heat and cattle do not grow.

MEASUREMENTS

When the problem started, the farmer found 3.58 volts in the cement where the cows stand.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

A new service was built in 1992. In 1975 an electrical transmission line was installed and there were no recent changes in the natural gas or oil pipeline near the farm.

The grounding wires were removed on the secondary neutral. The change only helped for a short time.

MITIGATION

In 1985 a neutral isolator was installed, the neutral isolator helped for only one year.

OBSERVATIONS

Symptoms have been observed for 8 years.

The problems on this farm were treated by the utility as being something other than stray voltage because of the nearness to the transmission line.

CASE 174

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production, began at 17,500 and dropped to 13,200

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts, rose to over 1,000,000

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

HUMAN HEALTH

1st person tingling or numbness in arms or legs

1st person frequent headaches
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person **weakness and pain in legs**
1st person forgetfulness
1st person ears ringing
1st, 2nd, and 3rd person pressure behind the eyes
1st, 2nd, and 3rd person unexplained nausea
1st, 2nd, and 3rd person unexplained general feeling of not being well
1st, 2nd, and 3rd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids

GENERAL INFORMATION

FARM CHARACTERISTICS

There are 3 sloughs located within 150 feet of the barn. The barn is pole type with a metal exterior.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusually high rate of battery failures
Occasional shocks from water lines and faucets
Unexplained fluctuation in electric bills.
Accelerated corrosion of well casings or other buried pipes.

HISTORICAL BACKGROUND

The farmer has lived on this farm for 18 years and is in the 30's age group. The farmer quit his milking operation approximately 5 years ago. The reason for quitting was the inability of experts to identify the cause of the problems on his farm. Blood samples were sent to the university and the university analysts found nothing abnormal.

MEASUREMENTS

Before isolation, more than 2.5 VAC was measured between the neutral and reference.

MITIGATION

An isolator was installed on the farm but apparently did not solve the problem.

CASE 175

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints--starts with feet and works up through joints to the hips. They have lost about 20 cows.

High veterinarian bills

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk?

Cattle's eyes bulge out

CALVES

Some calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die
Pigs also have swollen joints

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs
1st person frequent headaches
1st and 2nd person frequent flu-like or cold symptoms
1st and 2nd person vision problems (e.g., blurred or heavy eyelids)
1st person excessive fatigue
1st person often feeling under stress
1st and 2nd person weakness and pain in legs
1st person allergies
1st person pressure behind the eyes
1st and 2nd person unexplained nausea
1st person unexplained general feeling of not being well
1st person rheumatoid arthritis
2nd person (female) problems with menstrual cycle

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a major electrical transmission line located 50 yards from the farm.

There is pipe line 1/4 of a mile from the barn.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Increasing motor burnouts
Noisy telephone requiring frequent service calls or having false rings
Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

Fourteen months ago the stray voltage problem on this farm started. It began when the utility company changed the pole in the yard that holds the electrical service. On that same day the service was changed from 200 A service to 400 A service. They had the utility company come out, and they did not find anything. They have also had several electricians come to the farm; consequently, almost all of the wiring has been redone. Yet, the problem still exists.

OBSERVATIONS

The symptoms have been observed for 14 months.

The human and animal symptoms were observed within the same time frame.

CASE 176

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among unmilked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats cease to bear litters or give birth to small, unhealthy litters

HUMAN HEALTH

2nd person tingling or numbness in arms or legs

1st, 2nd, and 3rd person frequent headaches
1st, 2nd, and 3rd person frequent flu-like or cold symptoms
1st and 2nd person excessive fatigue
1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st person ears ringing
1st and 3rd person unexplained nausea
1st person unexplained general feeling of not being well
2nd person rheumatoid arthritis

GENERAL INFORMATION

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failures
Radio and TV failures not related to lightening storms
Increasing motor burnouts
Noisy telephone requiring frequent service calls or having false rings
Unexplained fluctuation in electric bills.

HISTORICAL BACKGROUND

The farmer is in the 30's age group

MEASUREMENTS

The fact that no isolation device was recommended would imply that the cow contact voltages were below the 0.5 VAC considered unable to shock the cows.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

In March of 1992 the utility company came out to run a check. The following corrections were made: bigger transformer was installed, new wires installed from the transformer to the meter, new transfer motor in barn (220V). Things have improved since then, however there are still some problems remaining.

CASE 178

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Sixteen cows went down partially on June 11, 1991
Cows had to be forced into the parlor

Production

Poor milk production

Health

In a period of six years, over 200 cattle were lost to diseases caused by electric current stress on their immune system
Cattle have trouble walking

HUMAN HEALTH

Weakness in legs and feet
Loss of strength and energy
Severe mental anguish and stress

GENERAL INFORMATION

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Increasing motor burnouts

HISTORICAL BACKGROUND

In a period of six years, the family feels they have lost over 200 cattle to diseases caused by electric current stress on their immune systems. They have paid considerably for expert fees and tests. Their production loss in milk has also cost them considerably. The utility company first denied a problem, then shifted blame, and refused to offer reasonable solutions. A pattern of avoidance of issues and an inability to give straight answers to straight questions was apparent. On June 11, 1991, **7200 volts of electricity crossed an electrical insulator and went to the ground via the pole's guywire, which was not connected to the line's primary neutral.** Sixteen cows went down partially, machines went flying, and the farmers were fortunate not to be electrocuted or shocked badly. It was only when two cows were found dead, directly under the high line, 150 feet apart, that the dangerously flawed insulator was discovered.

MEASUREMENTS

Maximum primary neutral to earth voltage is 12 AC
Minimum primary neutral to earth voltage is 2 AC
Maximum secondary neutral to earth voltage is 6 AC

Cow contact at the water cup is 0.6 AC

Amperage on non connected grid, May 12 to Aug. 20, 100 Milli Amps. to 400 Milli Amps

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Changes made in the electric utility system are as follows: changed to closed delta transformer system, put in an isolator and removed underground primary wire and went to overhead. There are no electrical transmission lines that have recently been added and no natural gas or oil pipelines near the farm.

After installing the closed delta system, it stopped burning out 3ph motors. The average before was 12 motors a year in the range of 12 Hp to 15 Hp.

The electrical equipment change made on the farm is the removal of the ground from the milk transfer pump. This was a significant help for the cows going into the parlor.

MITIGATION

The utility installed a neutral isolator. The farmer installed 56 ground rod Grid System with 1000 ft. of No 6 copper wire on southwest side of buildings going from high resistant area to low resistant area. After installing the grid, the readings in the parlor went down by a third.

In correcting the problem December 11, 1991, for the year of 1992 production on 40 cows went up 409,000 pounds of milk, cattle stopped dyeing health problems vanished in two weeks. In the summer of 1993 problems started over again. Human health problems still come and go with the current problem.

OBSERVATIONS

After milliamps on the grid system were lowered from 420 - 440 to 4 the following was observed:

One section of the fence stall barn that cows seldom used was used to normal capacity. Increased the area the cows used by 1/4.

Of the 37 cows that were thought to have hoof rots, only 4 actually had foot rot. The rest (33 cows) had sore ankles and joints. After electric current was removed, all but one of these 33 cows recovered to normal walking.

CASE 179

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Poor milk production

Cow production peaking early and not holding

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Leukemia/anemia

Poor hair coat, constant lice problems

Heifers and cows have trouble getting up (legs seem numb)

PETS

Cats sickly with rough, dull and shaggy coats

HUMAN HEALTH

1st person allergies

1st person frequent leg cramps

GENERAL INFORMATION

FARM CHARACTERISTICS

Near the farm there is an electrical transmission line within a half of a mile. There is also an electrical isolation device such as an isolation transformer on the property of the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusual failure rate for incandescent bulbs

HISTORICAL BACKGROUND

This farmer has lived on this farm all of his life (30 years). They first started to notice problems occurring in 1983. They knew some procedures need to take place in order to resolve this problem. After talking to their vet, he was the first to tell them about stray voltage. The vet suggested for them to talk to the power company. The power company contacted someone from the university. The university sent out an individual, who brought out five different voltage blockers. Along with the representative from the university there was also representatives from five different power companies.

MEASUREMENTS

Before installing the isolator, 25V AC was measured around the milking barn. After the isolator was installed the voltage was reduced to 0.025 V AC.

After the installment of the isolator many of the problems have been less noticeable, but the ones specified still persist.

MITIGATION

This farm has been isolated.

OBSERVATIONS AND CONCLUSIONS

Even after the voltage blocker was installed (which is checked once a month by the power company) there are still some problems that are occurring . There are still prolonged heat cycles, and silent heats. Another problem is that they have not been able to increase their production level beyond the point that they are at now. They have been working with a nutritionist to balance their rations, but there has been no improvement for five years.

CASE 180

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

Leukemia/anemia

Inability to maintain weight in cold weather

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Excessive teeth found in feeders and feedbunk

Heifers have many complications when they freshen

CALVES

Unable to suck

PETS

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

1st person tingling or numbness in arms or legs

1st person vision problems (e.g., blurred or heavy eyelids)

1st person problems with breathing

1st person excessive fatigue

1st person frequent irritability

1st person often feeling under stress

1st and 2nd person weakness and pain in legs

1st person unexplained general feeling of not being well

GENERAL INFORMATION

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusual failure rate for incandescent bulbs

Increasing motor burnouts

Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

This farmer has lived on this farm for 15 years. The symptoms have been occurring for five years. The power company checked for stray voltage 5 years ago and the results came back that there was no stray voltage at that time.

CASE 181

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Inflamed sphincter valve (even among un milked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Excessive teeth found in feeders and feedbunk

CALVES

Calves unable to grow at normal rate

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person frequent flu-like or cold symptoms
1st person vision problems (e.g., blurred or heavy eyelids)
1st person excessive fatigue
1st person frequent irritability

1st person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
1st person ears ringing
1st person unexplained nausea
1st person rheumatoid arthritis

GENERAL INFORMATION

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusual failure rate for incandescent bulbs
Unusually high rate of battery failures
Radio and TV failures not related to lightening storms
Occasional shocks from water lines and faucets
Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

This farm family had operated dairy farms for a number of years. They have lived on this particular farm for 47 years.

OBSERVATIONS

The problems have been occurring for a long period of time. The farmer has had a majority of the problems outlined. So far the utility has made no changes to migrate the problem.

CONCLUSION

This is a typical stray voltage farm without sufficient high cow contact with voltages to justify isolations.

CASE 182

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Heifers and cows have trouble getting up (legs seem numb)

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

- 1st and 2nd person tingling or numbness in arms or legs
- 2nd and 3rd person frequent headaches
- 1st, 2nd, and 3rd person frequent flu-like or cold symptoms
- 1st, 2nd, and 3rd person excessive fatigue
- 1st, 2nd, and 3rd person frequent irritability
- 1st, 2nd, and 3rd person often feeling under stress
- 1st, 2nd, and 3rd person weakness and pain in legs
- 2nd and 3rd person forgetfulness
- 3rd person ears ringing
- 2nd and 3rd person pressure behind the eyes
- 1st, 2nd, and 3rd person unexplained general feeling of not being well
- 1st person high incidence of non-malignant body tumors
- 2nd person (female) feeling bloated/retaining body fluids
- 3rd person having an illness that medical professionals cannot diagnose

GENERAL INFORMATION

FARM CHARACTERISTICS

The farm has had effects from the 400 KV DC transmission lines that is located 4 miles north of the farm. They have had the problem checked by electrical specialists and it has been described as stray voltage. In order to make some changes to prevent this problem from happening they have put in a few ground wires and new poles.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

- Unusually high rate of battery failures
- Increasing motor burnouts
- Accelerated corrosion of well casings or other buried pipes.

HISTORICAL BACKGROUND

This farm family had operated dairy farms for a number of years. This particular farm has been living on this farm for his whole life (60+ years). There are four members of the family, all who have been exposed and reacted to the stray voltage in some way or another.

OBSERVATIONS

The family has been noticing these symptoms for 48 months.

CASE 183

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Cow production peaking early and not holding
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles

PETS

Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die

HUMAN HEALTH

- * 2nd person tingling or numbness in arms or legs
- * 1st and 2nd person frequent flu-like or cold symptoms
- 1st person problems with breathing
- 1st person excessive fatigue
- 1st person frequent irritability
- * 1st person often feeling under stress
- * 1st person weakness and pain in legs
- * 1st and 2nd person forgetfulness
- * 1st person pressure behind the eyes
- * 1st person rheumatoid arthritis
- * 2nd person (female) feeling bloated/retaining body fluids

- * Members of the family regularly treated for these symptoms

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a natural gas or oil pipe line within 400 yards of the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)

HISTORICAL BACKGROUND

The farmer has lived on this farm for 30 years and is in the 50's age group. Stray voltage problems were present in the barn but resolved. There have been measured stray voltage in the farm yard but is not believed to be entering the barn.

OBSERVATIONS

Symptoms observed up to two years.

The human and animal symptoms occur within the same time frame.

CONCLUSIONS

There is most certainly some problems still present on this farm

CASE 184

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

High veterinarian bills

Leukemia/anemia (one cow)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

HUMAN HEALTH

1st person tingling or numbness in arms or legs

1st person frequent headaches

1st person problems with breathing

1st person excessive fatigue

1st person weakness and pain in legs

1st person forgetfulness

1st person ears ringing

1st person unexplained general feeling of not being well

1st person having an illness that medical professionals cannot diagnose

1st person occurrence of heart related ailments

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a natural gas or oil pipe line within 35 yards of the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Occasional shocks from water lines and faucets

Noisy telephone requiring frequent service calls or having false rings

HISTORICAL BACKGROUND

The farmer has lived on the farm for 17 years and is in the 60's. There has been an ongoing problem for many years with the pipeline. The problem involves the direct currents on the pipeline.

CASE 185

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Diarrhea

PETS

Cats sickly with rough, dull and shaggy coats

HUMAN HEALTH

1st, 2nd, and 3rd person frequent headaches

1st, 2nd, and 3rd person frequent flu-like or **cold symptoms**

1st, 2nd, and 3rd person vision problems (e.g., blurred or heavy eyelids)

1st person problems with breathing

1st, 2nd, and 3rd person excessive fatigue

1st and 3rd person frequent irritability
1st and 3rd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st and 2nd person forgetfulness
1st, 2nd, and 3rd person allergies
1st person ears ringing
1st person pressure behind the eyes
1st person unexplained nausea
1st person unexplained general feeling of not being well
* 2nd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
2nd person (female) problems with menstrual cycle
2nd person occurrence of heart related ailments

* Symptoms for which members of the household have been regularly treated.

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a major electrical transmission line near the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusually high rate of battery failures
Radio and TV failures not related to lightening storms
Occasional shocks from water lines and faucets
Accelerated corrosion of well casings or other buried pipes
Unexplained fluctuation in electric bills.

HISTORICAL BACKGROUND

The farmer has lived on the farm for 28 years and is in the 50's age group.

MITIGATION

The farm is isolated.

OBSERVATIONS

Human and animal symptoms observed within the same time frame.

Symptoms noted during the winter months.

CASE 186

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inflamed sphincter valve (even among un milked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
Excessive teeth found in feeders and feedbunk

CALVES

Unable to suck and rolls tongue

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Turkey died at full maturity
Ducks die at first 2 weeks

HUMAN HEALTH

1st person tingling or numbness in arms or legs
* 1st, 2nd, and 3rd person frequent headaches
1st, 2nd, and 3rd person frequent flu-like or cold symptoms

1st person excessive fatigue
2nd and 3rd person frequent irritability
1st person often feeling under stress
1st person weakness and pain in legs
1st, 2nd, and 3rd person forgetfulness
1st and 2nd person pressure behind the eyes
1st person unexplained nausea
1st person rheumatoid arthritis
2nd person (female) problems with menstrual cycle (very heavy)

* Symptoms for which members of the household were treated regularly

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a natural gas or oil pipe line within 200 yards of the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failures
Radio and TV failures not related to lightening storms
Noisy telephone requiring frequent service calls or having false rings
Accelerated corrosion of well casings or other buried pipes.
Unexplained fluctuation in electric bills.

HISTORICAL BACKGROUND

The farmer has lived on the farm for 50 years and is in the 50's age group.

MITIGATION

The farm is isolated.

OBSERVATIONS

Human and animal symptoms observed within the same time frame>

Symptoms observed for many years.

CASE 187

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among unmilked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

HUMAN HEALTH

1st, 2nd, and 3rd person tingling or numbness in arms or legs
1st and 2nd person frequent headaches
1st and 2nd person frequent flu-like or cold symptoms
1st and 2nd person vision problems (e.g., blurred or heavy eyelids)
1st and 2nd person problems with breathing
1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability

1st and 2nd person often feeling under stress
1st, 2nd, and 3rd person weakness and pain in legs
1st and 2nd person forgetfulness
1st and 3rd person allergies
1st and 2nd person ears ringing
1st and 2nd person pressure behind the eyes
1st, 2nd, and 3rd person unexplained nausea
1st and 2nd person unexplained general feeling of not being well
1st and 2nd person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
* 2nd person having an illness that medical professionals cannot diagnose
3rd person just sleeps at home

* Symptoms for which family members have been regularly treated.

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a major electrical transmission line half a mile east of the farm, and the distribution line is half a mile west of the farm. In addition the 400 mvDC line is approximately 1.5 miles away.

There is a natural gas or oil pipe line within a half a mile of the farm

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failures
Increasing motor burnouts

HISTORICAL BACKGROUND

The farmer has lived on the farm for 58 years and is in the 50's age group.

OBSERVATIONS

Symptoms observed for 30 months. The farmer marks this point as the time when the utility buried their power line and the neighbors had a 3 phase electric line installed.

CASE 188

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

Leukemia/anemia

Inflamed sphincter valve (even among unmilked heifers)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

1st person tingling or numbness in arms or legs

1st, 2nd, and 3rd person frequent headaches

2nd person frequent flu-like or cold symptoms

2nd person vision problems (e.g., blurred or heavy eyelids)

2nd person problems with breathing

2nd person excessive fatigue

2nd person frequent irritability

2nd person often feeling under stress

1st and 2nd person weakness and pain in legs
2nd person forgetfulness
2nd person allergies
2nd person ears ringing
2nd person pressure behind the eyes
2nd person unexplained general feeling of not being well

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a DC transmission line within one and one-quarter miles of the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failures
Radio and TV failures not related to lightening storms
Occasional shocks from water lines and faucets
Noisy telephone requiring frequent service calls or having false rings

HISTORICAL BACKGROUND

The farmer is in the 50's age group.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The entire farm was rewired. No correlating effects were noted.

MITIGATION

The electric utility could find no stray voltage problem on the farm. The utility personnel recommend that the farmer rewire the farm. After rewiring the farmer experienced no improvement in the stray voltage effects.

OBSERVATIONS

Symptoms observed for eight and a half years.

Case 189
ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY
DAIRY OPERATOR

CATTLE

Behavior

- poor water consumption
- cows reluctant to enter barn and/or stalls
- cattle dancing back and forth in stalls
- cattle kicking milkers off
- cattle pressing their noses against stall pipes, water cups, or cement curbs

Production

- Uneven, incomplete and/or slow milkout
- poor milk production
- cow production peaking early and not holding

Health

- multiple or recurring mastitis (not responding to treatment)
- breedback difficulties
- swollen legs and joints
- high somatic cell counts
- high veterinarian bills
- inability to maintain weight in cold weather
- poor hair coat, constant lice problems
- tough hides which result in bent and broken injection needles
- breeding problems, such as: silent heats, absorptions, and spontaneous abortions
- immune system failures resulting in Chlamydia, pneumonia, and Bovine Viral Diarrhea (BVD)

CALVES

- calves having poor survival rate
- calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

- cats cease to bear litters or give birth to small, unhealthy litters
- cats leave farm and die

HUMAN HEALTH

- 1st and 2nd person tingling or numbness in arms or legs
- 2nd person frequent headaches
- 1st person frequent flu-like or cold symptoms
- 1st person vision problems (e.g, blurred or heavy eyelids)
- 1st and 2nd person excessive fatigue
- 1st and 2nd person often feeling under stress
- 1st and 2nd person weakness and pain in legs
- 1st person forgetfulness

1st person ears ringing

GENERAL INFORMATION

FARM CHARACTERISTICS

The farmer is in his 40's and has lived on his farm for 22 years.

ELECTRICAL PROBLEMS ON THE FARM

The farmer has experienced increased motor burnouts on his equipment and machinery.

MITIGATION

The farm has been isolated.

OBSERVATIONS AND CONCLUSIONS

The stray voltage problem has somewhat improved with the installation of the isolator, but the farmer still experiences a high cull rate and high somatic cell counts among his cattle. The cows behavior has improved somewhat, however.

CASE 190

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

cattle dancing back and forth in stalls
cattle kicking milkers off
cattle pressing their noses against stall pipes, water cups or cement curbs
excessive tail switching

Production

poor milk production
uneven, incomplete and/or slow milkout
cow production peaking early and not holding

Health

multiple or recurring mastitis (not responding to treatment)
breedback difficulties
high somatic cell counts
tanish discharge under eyes, nostrils, and ears
stress rings on the hoofs (excessive growth)
heifers and cows have trouble getting up (legs seem numb)
breeding problems, such as: silent heats, absorptions, and spontaneous abortions

CALVES

PETS

Cats sickly with rough, dull and shaggy coats

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person frequent headaches
1st person excessive fatigue
1st person weakness and pain in legs
1st person pressure behind the eyes
1st person unexplained general feeling of not being well

GENERAL INFORMATION

FARM CHARACTERISTICS

The farmer has lived on his farm for 41 years and is in his 40's. The farm is located 3/4 mile from a major electrical transmission line.

ELECTRICAL EFFECTS ON THE FARM

Noisy telephone requiring frequent service calls or having false rings.

Accelerated corrosion of well casings or other casings or electric bills

ELECTRICAL PROBLEMS ON THE FARM

The farmer has experienced noisy telephone rings and false rings requiring frequent service calls. The farmer has also noticed accelerated corrosion of well casings or other buried pipes.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Since the isolator was installed in 1992, the cattles' somatic cell counts have been lowering, however, they are still higher than normal. Before 1992 the cell counts were 900,000 and now they are somewhere between 500,000 and 700,000.

MITIGATION

The farm has been isolated.

CASE 191

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout
Poor milk production, began at 17,500 and dropped to 13,200
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts, rose to over 1,000,000
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

PETS

Cats sickly with rough, dull and shaggy coats
Cats leave farm and die

HUMAN HEALTH

1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
1st person allergies
1st person ears ringing

GENERAL INFORMATION

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusual failure rate for incandescent bulbs
Radio and TV failures not related to lightening storms
Occasional shocks from water lines and faucets

HISTORICAL BACKGROUND

The farmer has been on this farm for 58 years. They have been noticing problem for the last couple of years. They periodically experienced high stray voltage recordings and dimming of lights when small appliances were being used. Some occurrences that took place were dimming and flickering of the lights. These seemed to be taking place for no apparent reason.

The power company came and changed all connecting bolt clamps with a new style of clamp. Since then the problem has been corrected so the voltage is less than 0.5 VAC. The power company is also going to replace the distribution line next spring. The power company believes this will eliminate the entire problem.

OBSERVATIONS

OBSERVATIONS

The farmer has been experiencing the symptoms for 24 months. After the power company was contacted the problem was taken care of almost right away. As of right now stray voltage doesn't seem to be a problem for this farmer but many of the symptoms remain.

CASE 192

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production, began at 17,500 and dropped to 13,200

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts, rose to over 1,000,000

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Heifers and cows have trouble getting up (legs seem numb)

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

Calves are weak at birth

PETS

Cats sickly with rough, dull and shaggy coats

Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

Dog has stiff joints

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs

2nd person frequent headaches
2nd person frequent flu-like or cold symptoms
2nd person problems with breathing
2nd person excessive fatigue
2nd person frequent irritability
2nd person often feeling under stress
2nd person weakness and pain in legs
2nd person forgetfulness
2nd person allergies
2nd person pressure behind the eyes
2nd person unexplained nausea
2nd person unexplained general feeling of not being well
2nd person (female) feeling bloated/retaining body fluids
2nd person having an illness that medical professionals cannot diagnose

GENERAL INFORMATION

FARM CHARACTERISTICS

This farmer feels that he has a stray voltage problem. There is a natural gas or oil pipe line within 1/4 of a mile from the farm. There is also an electrical isolation device on the property.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Radio and TV failures not related to lightening storms
Unexplained fluctuation in electric bills.

HISTORICAL BACKGROUND

The farmer has been living on this dairy farm for 30 years. They have been noticing the symptoms of stray voltage for 24 months. They have been experiencing a lot of symptoms and the doctor cannot diagnose the problem.

MITIGATION

This farm is isolated

OBSERVATIONS

On this farm serious problems exist for which no solution has been provided.

CASE 193

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts, rose to over 1,000,000
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person vision problems (e.g., blurred or heavy eyelids)
1st person excessive fatigue
1st person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
1st person neurological illness
1st person pressure behind the eyes
1st person unexplained general feeling of not being well

GENERAL INFORMATION

FARM CHARACTERISTICS

There is a natural gas or oil pipe line about 175 yard from the farm.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Unusual failure rate for incandescent bulbs
Radio and TV failures not related to lightening storms
Increasing motor burnouts
Noisy telephone
Unexplained fluctuation in electric bills.

HISTORICAL BACKGROUND

The farmer has lived on this farm for 40 years. The symptoms of stray voltage have been present for 48 months.

CASE 194

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven and incomplete milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

PETS

Cats leave farm and die

ELECTRICAL EFFECTS ON THE FARM

Accelerated corrosion of well casings or other buried pipes (electro's in the pipe system, had to clean two to three times a week)

HISTORICAL BACKGROUND

Has lived on the farm for 55 years

Is a dairy farmer and in the age group of 50's

Had stray voltage 13 years ago

MEASUREMENTS

Maximum secondary neutral to earth voltage is 7.0 AC
Minimum secondary neutral to earth voltage is 0.4 AC
Concrete floors to stall is 0.4 AC

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The two things done in changes in the electrical wiring are that they switched all the motors to 220V where feasible and installed grounding rods at various locations. An isolated transformer was installed to fix the stray voltage. There are no electrical transmission lines that have recently been added and no natural gas or oil pipelines near the farm.

A great change in production and health of the cows was observed. There was a great increase in production and much better health, but it took almost a year before production and health returned to normal.

MITIGATION

This farm has an isolation transformer.

CASE 195

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as rolls tongue, and diarrhea

PETS

Cats sickly with rough, dull and shaggy coats

Cats leave farm and die

Dog has hunch back and arthritis

HUMAN HEALTH

1st person tingling or numbness in arms or legs
1st person frequent headaches
1st person frequent flu-like or cold symptoms
1st person vision problems (e.g. blurred or heavy eyelids)
1st person excessive fatigue
1st person frequent irritability
1st person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
1st person allergies
1st person ears ringing
1st person pressure behind the eyes
1st person unexplained nausea
1st person unexplained general feeling of not being well
1st person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
1st person having an illness that medical professionals cannot diagnose

* 2nd person receives frequent medical help for TTP

ELECTRICAL EFFECTS ON FARM

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure
Increasing motor burnouts
Occasional shocks from water lines or faucets
Unexplained radio and TV interference
Noisy telephone requiring frequent service calls or having false rings?
Accelerated corrosion of well casings or other buried pipes
Unexplained fluctuations in electric bills

OBSERVATIONS

Symptoms increased when they were on the farm, but have improved since they moved off.

Symptoms observed for over 2 years.

Both times the wife was pregnant she was confined to bed. The last time she delivered a month early. She left the farm in May, but had problems when she came back, so she stays off now. She will carry to full term now. The daughter had problems with her knees until they started staying off the farm. The farmer's back improved when they left the farm. Everyone's general soreness and tiredness has improved since they left the farm

CASE 197

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Leukemia/anemia
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
No displaced stomachs

CALVES

Calves with symptoms such as abscesses, sore humps, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with tough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Ducks (die when they are between the age of nine days old and two weeks old)

HUMAN HEALTH

1st, 2nd, 3rd, 4th, 5th, and 6th person tingling or numbness in arms or legs
2nd person problems with breathing
2nd person excessive fatigue
2nd person frequent irritability
1st person often feeling under stress
2nd person weakness and pain in legs
1st person forgetfulness
1st person unexplained general feeling of not being well
2nd person rheumatoid arthritis

2nd person having an illness that medical professionals cannot diagnose
1st person joints burn (in the elbow)

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure
Increasing motor burnout's (bulk tank compressor motors)
Occasional shocks from water lines or faucets
Noisy telephone requiring frequent services calls or having false rings
Unexplained fluctuations in electric bills

HISTORICAL BACKGROUND

They have lived on their farm for 25 years
They have a natural gas line quarter a mile away
They are in the age group of 50's
They have had stray voltage for 10 years

MEASUREMENTS

Maximum primary neutral to earth voltage is 1.75 DC and 29.00 AC
Minimum primary neutral to earth voltage is 0.03 AC
Maximum secondary neutral to earth voltage is 149.00 AC
Minimum secondary neutral to earth voltage is 0.02 DC
Measurements of current on the primary grounding wires is 0.002 DC and 0.03 AC
Measurement of current on the secondary grounding wires is 0.02 DC and 0.03 AC
Between bonded water line and ground is 0.002 DC and 0.03 AC
5 volts were measured on cow contact before neutral isolator was installed

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The changes in the electrical wiring are as follows: a new dairy barn was built (used to much current and installed larger transformer), all new appliances were installed in the house and new wiring throughout farm. There were also changes made in the electric utility: a larger transformer was installed and the secondary ground was removed from the yard. There was no electrical transmission line added and no natural gas or oil pipeline near the farm.

The primary neutral was separated with a spark gap, and the secondary neutral was removed from the farm. The grounds were unhooked. By doing this the animals have improved somewhat, but the production still does not increase. Cows still dry up to soon.

MITIGATION

The neutral isolator fixed the spark gap, so they could at least milk again. They still had some high somatic counts, but nothing like before it was installed.

Electronic grounding system- the somatic cell count went to over one million, dropped 1.3 million after disconnecting the EGS. The utility kept records and vets saw this too.

While uncovering the stray voltage, the utility found out they had the wrong wire grounding the milker pump.

The change had no affect on the cows.

OBSERVATIONS

The farmer's management practices are very different from other farms. The farmer feels this helps them keep the animals longer.

The farmer found that when they milked with their generator, milk production increased and milking time was shortened considerably.

The farmer also had a chicken that was regenerating limbs that had been frozen. The chickens lived in the dairy barn.

CASE 198

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cattle dancing back and forth in stalls
Cattle would not drink out of the drinkers

Production

Poor milk production
Breedback difficulties
Cow production peaking early and not holding
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

High veterinarian bills
Inability to maintain weight in cold weather
Cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)
Excessive teeth found in feeders and feedbunk

PETS

Cats wouldn't go in the barn

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Increasing motor burnout's (bulk tank compressor motors)
Occasional shocks from water lines or faucets
Noisy telephone requiring frequent services calls or having false rings
Accelerated corrosion of well casings or other buried pipes
Radio and TV set failure (static)

HISTORICAL INFORMATION

Cows refuse to drink at drinking cups and stock tanks, after force feeding water with pumps. Stray voltage was discovered. Cows would drink from plastic buckets in barn and a different stock tank about 100 feet from barn, filled with a garden hose.

They have lived on their farm for 25 years
They have a natural gas line one mile away
They are in the age group of the 60's

They had stray voltage from 1989 to 1990

MEASUREMENTS

Minimum primary neutral to earth voltage is 1 AC

Maximum secondary neutral to earth voltage is 5 AC

Cows drinking cups and stock tank is 5 AC

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The changes in the electric utility system are as follows: seventeen poles were added, ten ground rods were added, cracked insulators were changed. There is an electrical transmission line near the farm. They tied the lines together about one half mile from the farm.

Primary neutral -- added ground rods

Secondary neutral -- added three ground rods

Electrical equipment -- added insulator

By making these changes the cows began drinking water and production went up.

MITIGATION

They installed a neutral insulator, and about one year later they changed copper water pipes to plastic.

By solving the problem the cows regained flesh and milk production went up.

CASE 199

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
Leukemia/anemia
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among un milked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves with symptoms such as abscesses, sore huns, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair
Calves have growth in nostril from birth

PETS

Cats sickly with tough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs
1st and 2nd person frequent headaches
1st and 2nd person frequent flu-like or cold symptoms

1st and 2nd person vision problems (e.g. blurred or heavy eyelids)
1st and 2nd person problems with berating
1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st and 2nd person forgetfulness
1st and 2nd person allergies
1st and 2nd person ear ringing
1st and 2nd person pressure behind the eyes
1st and 2nd person unexplained nausea
1st and 2nd person unexplained general feeling of not being well
1st and 2nd person rheumatoid arthritis
1st and 2nd person high incidence of non-malignant body tumors
1st person occurrence of malignant body tumors
1st person (females) feeling bloated/retaining body fluids
1st person occurrence of heart related ailments

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Incandescent lamp failures (sometimes in groups, explosions)
Unusually high rate of battery failure
Increasing motor burnout's (bulk tank compressor motors)
occasional shocks from water lines or faucets
Noisy telephone requiring frequent services calls or having false rings
Radio and TV set failure (non-lightning related)

HISTORICAL BACKGROUND

They have lived on their farm for 43 years
They are in the age group of 60's
They have observed symptoms of stray voltage for 25 years.

ELECTRICAL PROBLEMS AND CORRELATING EFFECTS

They added isolation equipment and the problems have increased. They are suffering greatly being at the end of the line.

CASE 200

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cows reluctant to enter barn and/or stalls
Cattle kicking milkers off

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorption's, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among un milked heifers)
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore humps, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs
1st, 2nd and 3rd person frequent headaches
1st, 2nd and 3rd person frequent flu-like or cold symptoms
1st, 2nd and 3rd person problems with berating
1st, 2nd and 3rd person excessive fatigue
1st, 2nd and 3rd person frequent irritability
1st and 2nd person often feeling under stress
1st and 3rd person weakness and pain in legs
1st person forgetfulness
1st, 2nd and 3rd person allergies
1st and 2nd person ear ringing
1st, 2nd and 3rd person unexplained nausea

1st, 2nd and 3rd person unexplained general feeling of not being well
1st and 2nd person rheumatoid arthritis
1st and 3rd person high incidence of non-malignant body tumors
2nd person having an illness that medical professionals cannot diagnose
1st person occurrence of heart related ailments

ELECTRICAL EFFECTS ON THE FARM

Noted were:

Noisy telephone requiring frequent services calls or having false rings
Accelerated corrosion of well casings or other buried pipes

HISTORICAL BACKGROUND

They have lived on their farm for 48 years
They have a electrical transformer 1/2 mile away
They are in the age group of 40,s

MEASUREMENTS

Maximum primary neutral to earth voltage is 100t AC
Minimum primary neutral to earth voltage is 0.1 AC
Maximum secondary neutral to earth voltage is 0.25 AC
Minimum secondary neutral to earth voltage is 0.05 AC
Milking parlor is 0.06 DC
3/4 Amps have been measured on primry

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The changes in the electrical wiring are that they completed a four wire and removed abandoned 7200v under ground. A new transformer was installed on the place and next door neighbors replaced isolators. The electrical transmission line was new in 1981.

Primary neutral -- was cut -- now rehooked
Secondary neutral -- four wire
Electrical equipment -- copper grid

The changes observed are as listed: sick cattle, lame cattle, low production, calf less then a week, no sucking instinct.

MITIGATION

Isolator was installed in 1984. Things were better for a number of years now. The community built a new sewage plant 1 1/4 mile from the farm this summer, now they have more problems. They are 1 1/2 miles from a transmission line and the a river flows between that and the farm.

The farm is very low resistance the farmer believes the high primary neutral in the yard is causing ground currents and affecting the cattle and the family. They have had to move from the house.

CASE 201

ANIMAL AND HUMAN WELL BEING AS OBSERVED BY DAIRY OPERATOR

CATTLE

Behavior

Reluctance of cows to step on concrete holding pen, barn, stalls, and feeder
Once in the stalls the cows fought
Extreme nervousness

Production

Recurring mastitis

HUMAN HEALTH

High stress level
Frequent nightmares

GENERAL INFORMATION

FARM CHARACTERISTICS

Power panel in the barn load balanced by shifting breakers on bus bars

All wiring inside barn is in metal conduit with compression type fittings. A green equipment ground wire is running to power panel neutral bar and copper clad ground rod.

All metal parts in milking area are bonded together and to the buried wire in floors and holding area and approach. connections either welded or tapped and threaded with set screw and compression wire connections on 9-10 #6 wire put in floor

The facility is block and wood with pipe stalls and a pipeline milker. The stalls are surge by-pass.

The barn equipment is just the usual: milker, tank, and wash down hose.

HISTORICAL INFORMATION

Electric co-op supervisory personnel insisted that trouble was originating on farm and not coming off primary neutral system--could not come to agreement with farm owner on installation of isolation device(zapper) because owner was asked to sign what amounted to a release of all liability against utility co.

At beginning of problem the farmer had a Simpson 260 multi meter that has a scale 0 to 3 volts AC. He had it checked at co-op meter check lab for accuracy but they only checked on high scales and technicians said they did not bother to read any low voltages such as they were concerned with.

MEASUREMENTS

115 volt shallow well pump changed to 230 volts (9-3-91)

Stray voltage was measured between neutral bar in power panel and isolated copper clad ground rod in wet soil area at barn drainage outlet about 200 - 250 feet from barn as well as various places in barn. Readings were consistently higher when measured at neutral bar in panel and the greater the barn electric load the higher the reading.

On about 9-21 the utility line superintendent met the farmer at the farm, he had what appeared to be a new Simpson 260 meter he hooked up to neutral in barn the stray volts increased according to a steady peak of 3 to 4 volts and spike up to 10 when single phase motor started and capacitors kicked start windings. The line superintendent immediately said "see it is all being caused there by the barn equipment. At the time I already had tractor powered 15 kW energy generator set up and insisted he observe same test with the generator powering same equipment. The meter needle barely wiggled with the same equipment loading. It seemed to surprise him and he made no comment, just closed the meter cover and he got in his truck and left.

The questions that refer to primary and secondary neutrals, because the two are directly connected at transformer separate readings are not meaningful. The on DC volts found were in milking area and were very low (0.5 v or less) and were not included in AC reading because a capacitor was installed in series on list lead of meter. It was thought to be originating from chemical action of animal excrement and cleaning agents on concrete floor.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

Brush removed in area near farm for up to about two miles from utility line 7200 volts primary.

At least some effort made to check pole grounds and primary neutral. There are also some attempts to balance 30 supply lines in general area.

New transformer pole near barn with new #6 grid wire and 50 # salt placed bottom of hole--(coop workers)

The last changes in the grounding wire that the utility performed had from about 50 ft before holding pen to metal to doors that cows enter milking area was 3 - 8 ft x 5/8" copper clad rods driven at a slope away from sloping trench with #16 bare ground wire also clad to rods with bronze rod clamps - there is a water line from well to old barn going across the area that cows go over to reach holding pen. When well pump was on 115 V the capacitor surge may reached the animals. General rains in late September and October may have helped overhaul the neutral system. Cows appear nervous for weeks, some possibly months. Farm owner tells of lost production and some good producers never returned to former rate of milking

OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

Early in the morning, stray voltage increased at a time that neighboring utility customers were starting the day and cooking breakfast -- lower in the mid day and increased again later in the afternoon corresponding with higher electric usage system wide.

Over period of several weeks varied and slight improving on voltage and cattle reaction were noted

CONCLUSIONS

Basically the entire barn area had an electric charge coming from the power line not being able to carry the imbalance current back to the distribution system. In this case, by building a grid over the area cows had to transit and sloping the approach the cows seem to be affected less and overcame the reluctance to

enter area to be fed and milked. The farmer's belief is that the co-op most certainly knew what was happening but tried to shift any blame to him and the equipment.

CASE255

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption

Cows reluctant to enter barn and/or stalls

Cattle dancing back and forth in stalls

Cattle kicking milkers off

Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout

Poor milk production

Breedback difficulties

Cow production peaking early and not holding

High somatic cell counts

Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)

Swollen legs and joints

High veterinarian bills

Leukemia/anemia

Inability to maintain weight in cold weather

Poor hair coat, constant lice problems

Inflamed sphincter valve (even among un milked heifers)

Tanish discharge under eyes, nostrils, and ears

Stress rings on the hoofs (excessive growth)

Heifers and cows have trouble getting up (legs seem numb)

Tough hides which result in bent and broken injection needles

Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate

Calves unable to grow at normal rate

Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die
Dog will not stay in barn, no matter how cold outside

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs
1st and 2nd person frequent headaches
1st and 2nd person frequent flu-like or cold symptoms
1st and 2nd, person vision problems (e.g. blurred or heavy eye lids)
1st and 2nd person problems with breathing
1st and 2nd person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st and 2nd person forgetfulness
1st and 2nd person ears ringing
1st and 2nd person unexplained nausea (all the time)
1st and 2nd person unexplained general feeling of not being well
1st person rheumatoid arthritis
2nd person (female) feeling bloated/retaining body fluids
2nd person (female) problems with menstrual cycle

EQUIPMENT AND MACHINERY PROBLEMS

Noted were:

incandescent lamp failures (sometimes in groups, explosions)
unusually high rate of battery failure
radio and TV set failure (non-lightening related)
increasing motor burnouts
occasional shocks from water lines or faucets
noisy telephone requiring frequent service calls or having false rings
accelerated corrosion of well casings or other buried pipes (stainless steel pump casing replaced because of rust)

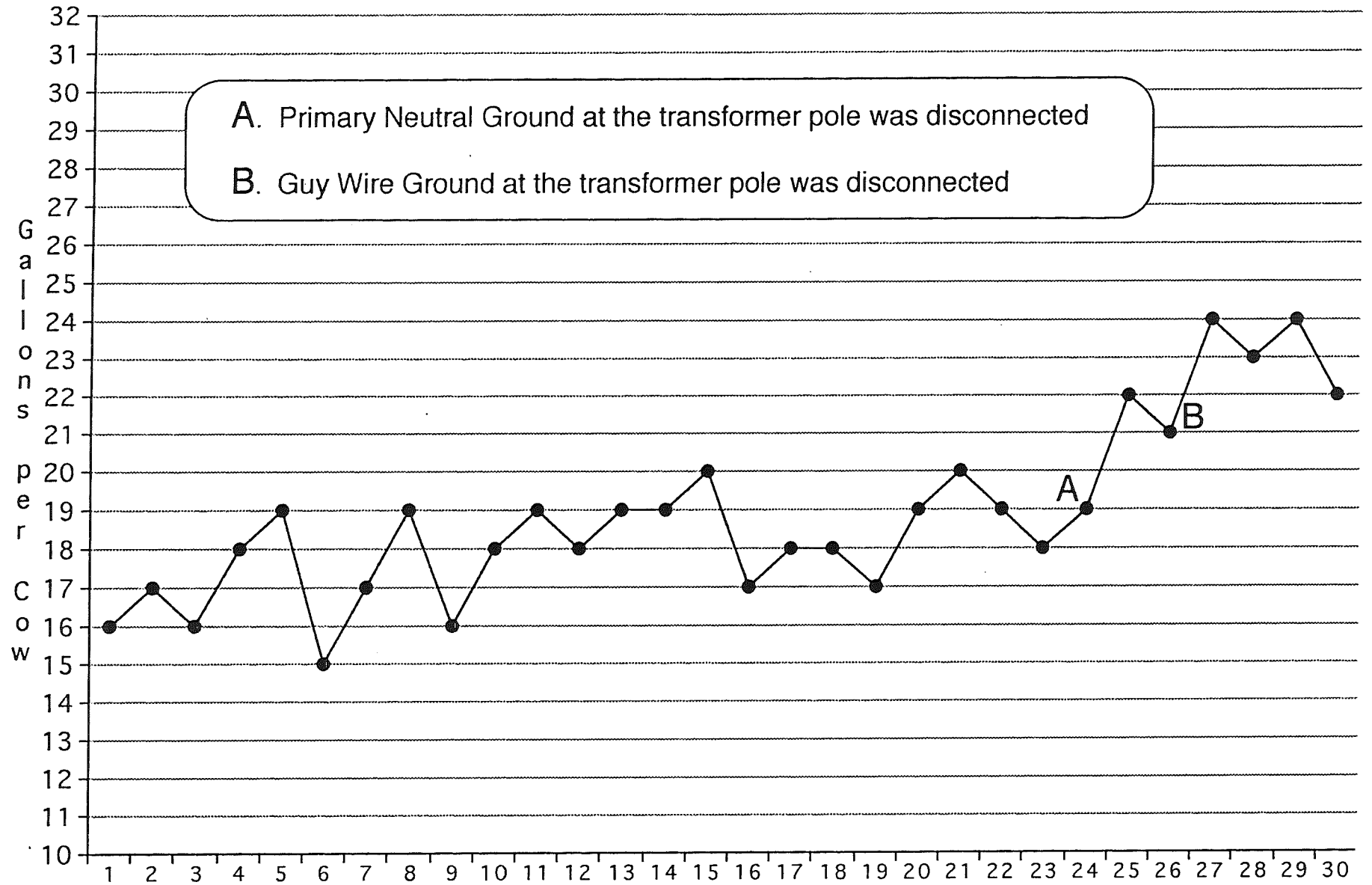
OTHER INFORMATION

Symptoms observed for 72 months
Human and pet symptoms occur during the same time frame
1st person checked for upset stomach and hyperventilation by a medical professional

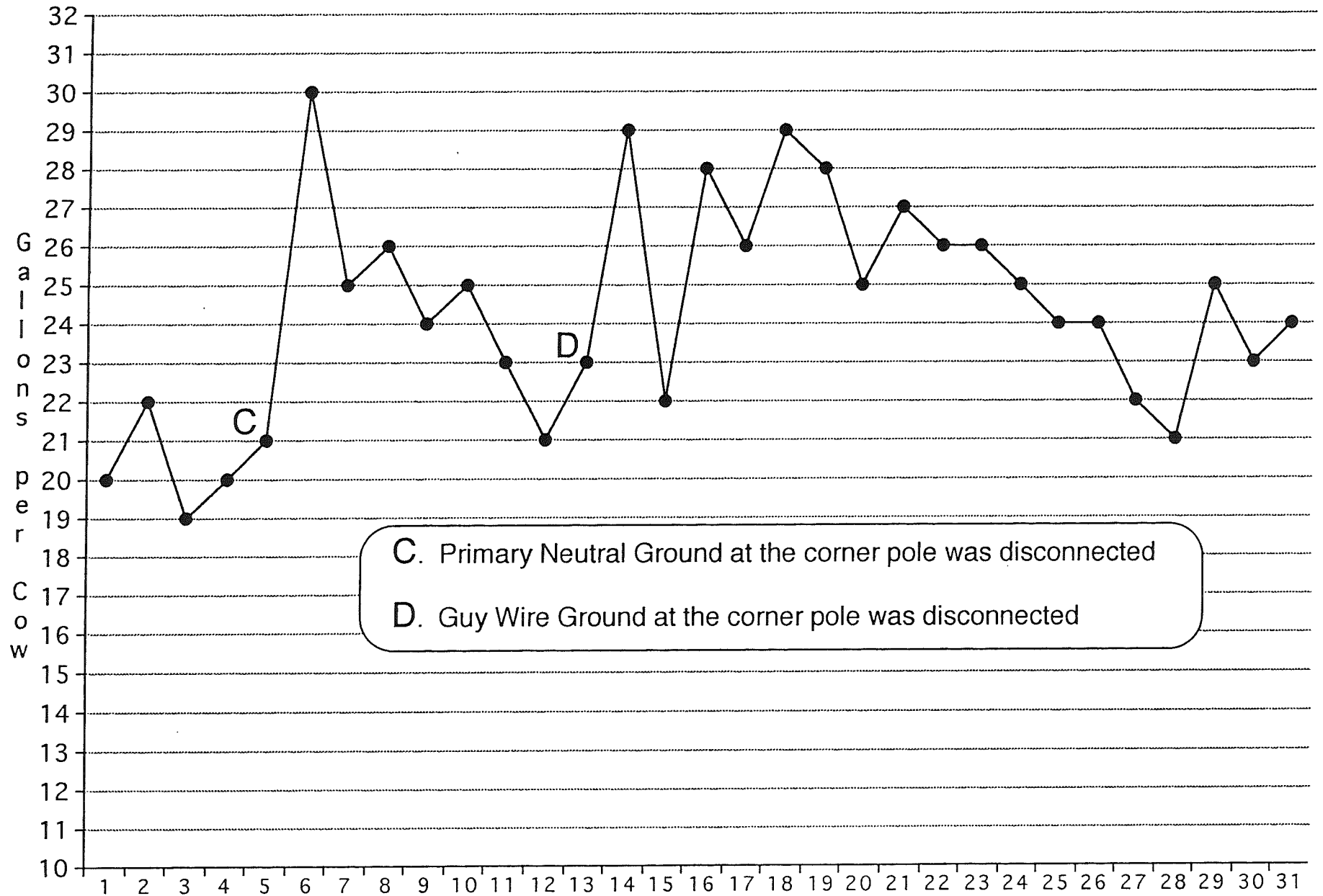
CHANGES IN FARM OPERATION - DARRELL FRANZE

- A. Primary Neutral Ground at the transformer pole was disconnected
- B. Guy Wire Ground at the transformer pole was disconnected
- C. Primary Neutral Ground at the corner pole was disconnected
- D. Guy Wire Ground at the corner pole was disconnected
- E. Lake Region Electrical Coop. Reconnected the four grounds (A-D)
- F. All four grounds disconnected (A-D)
- G. On March 14, 1994, the Primary Neutral Grounds were reconnected, anticipating a site visit by Lake Region Electrical Coop.
- H. On March 17, 1994, the Primary Neutral Grounds at the transformer pole were disconnected
- I. On March 19, 1994, the transformer pole was relocated, and associated Primary Neutral Grounds
- J. On February 23, 1994, the Primary Neutral Grounds were disconnected at the transformer pole and at the corner pole (four spans away from the transformer pole)
- K. Starting on April 23, 1994, the cows were turned out during the day and night in a loafing cow yard
- L. Cows were in for only one day on May 3, 1994
- M. Cows were in for two days on May 13-14, 1994
- N. Cows were in for only one day on May 22, 1994
- O. Cows were in for two days on June 15-16, 1994
- P. Cows were in for only one day on June 25, 1994
- Q. Cows were in for three days on July 5-7, 1994
- U. On August 19, 1994, the Primary Neutral Grounds at the transformer pole and the corner pole were reconnected by Lake Region Electrical Coop during their Voltage Reduction Plan (on-farm inspection)
- V. On September 19th and 20th (approximately), a new single phase line extension was built near the Franze farm
- W. On October 16, 1994, cows were left in the barn until November 8th
- X. On November 8-12, 1994, cows were turned out during the day and night in the loafing cow yard
- Y. On November 12, 1994, cows were kept in for the winter

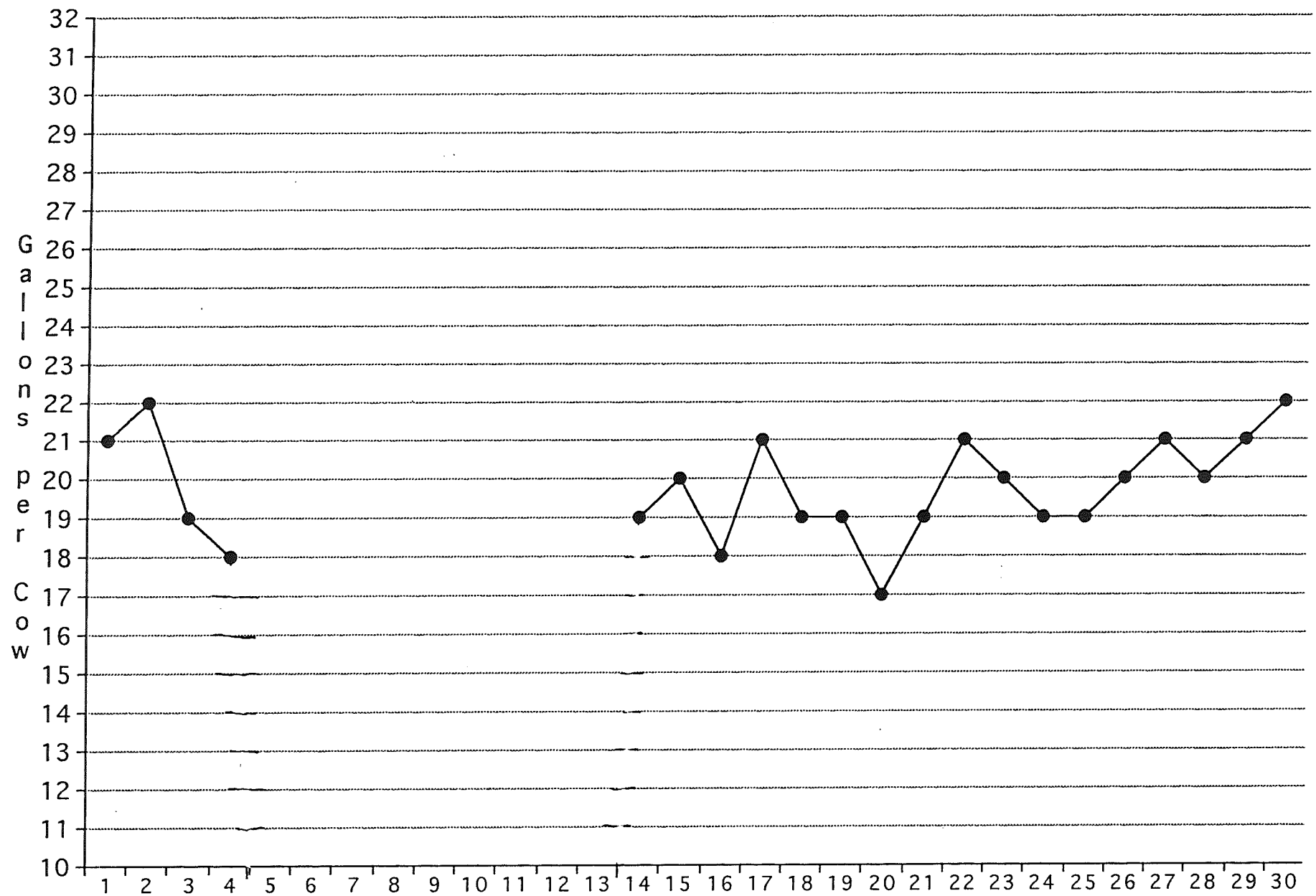
April 1992 Water Meter Readings



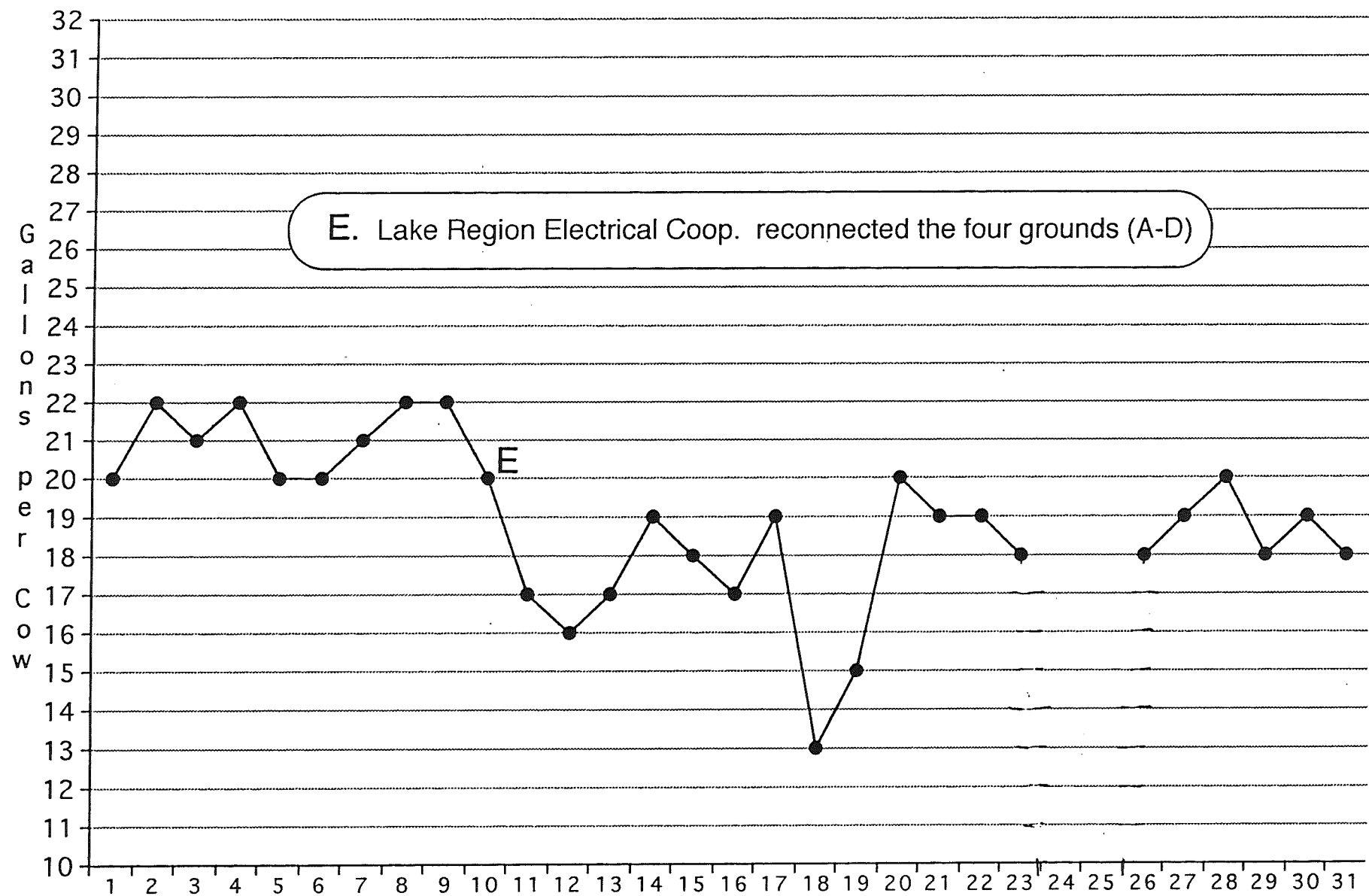
May 1992 Water Meter Readings



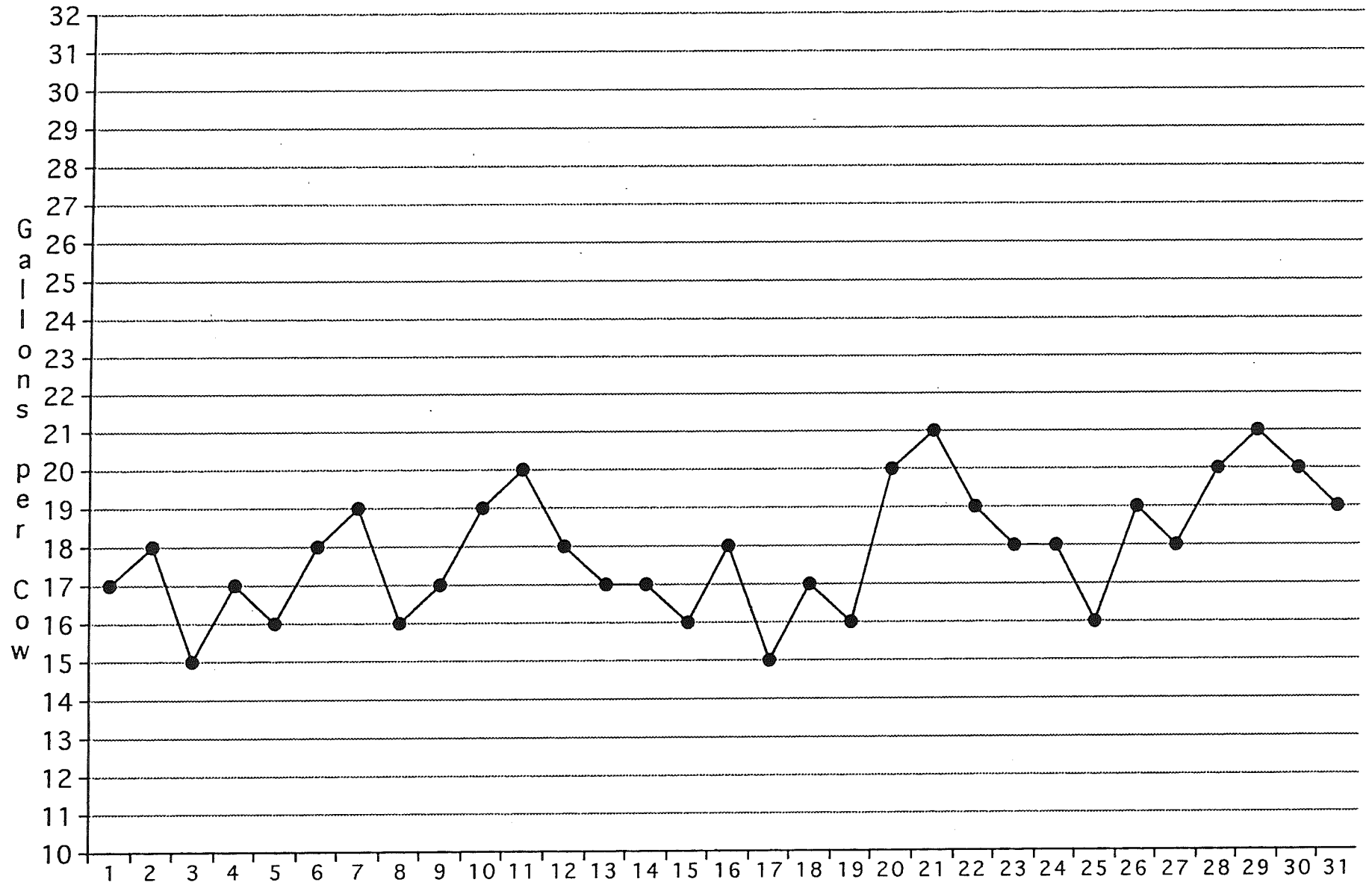
June 1992 Water Meter Readings



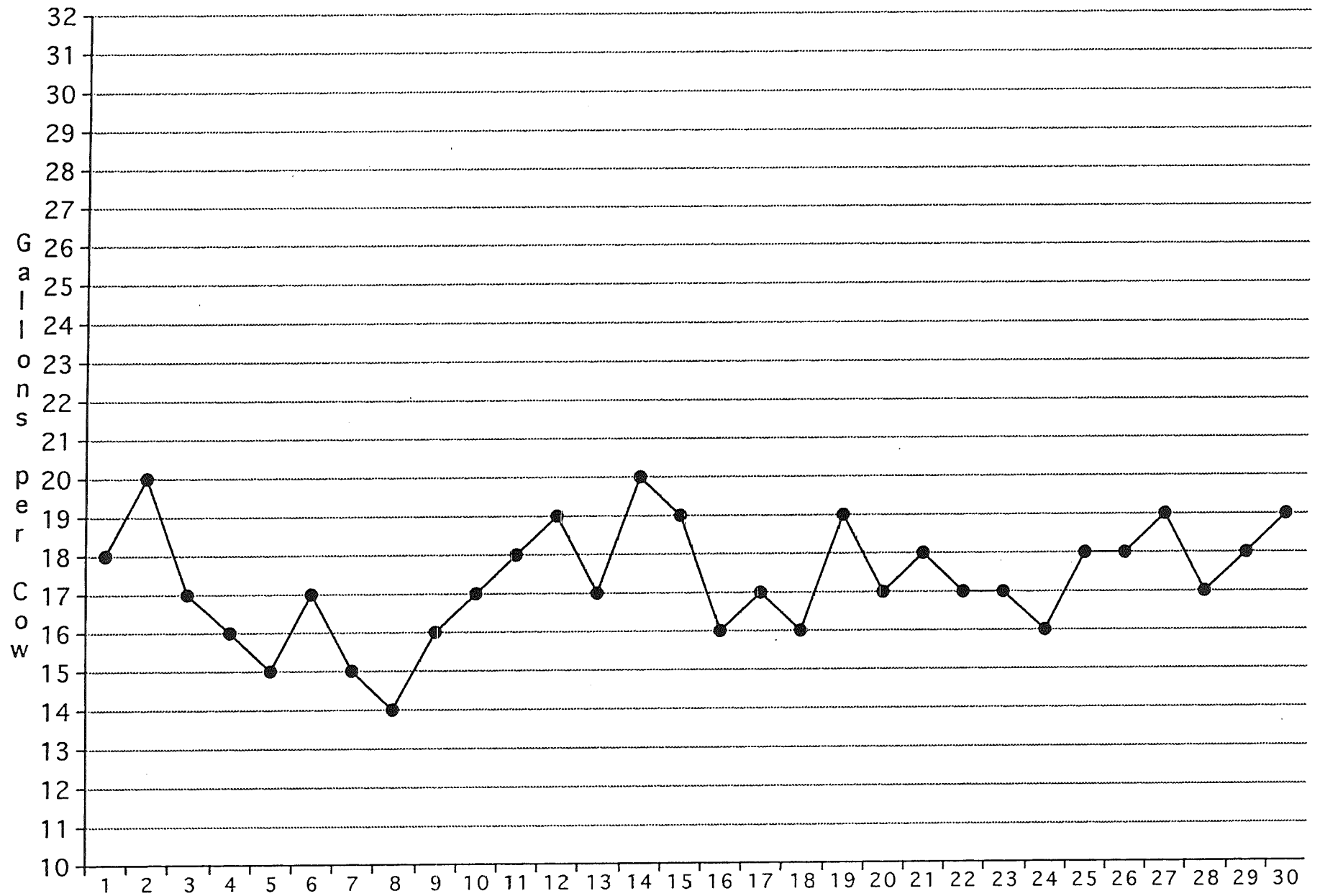
July 1992 Water Meter Readings



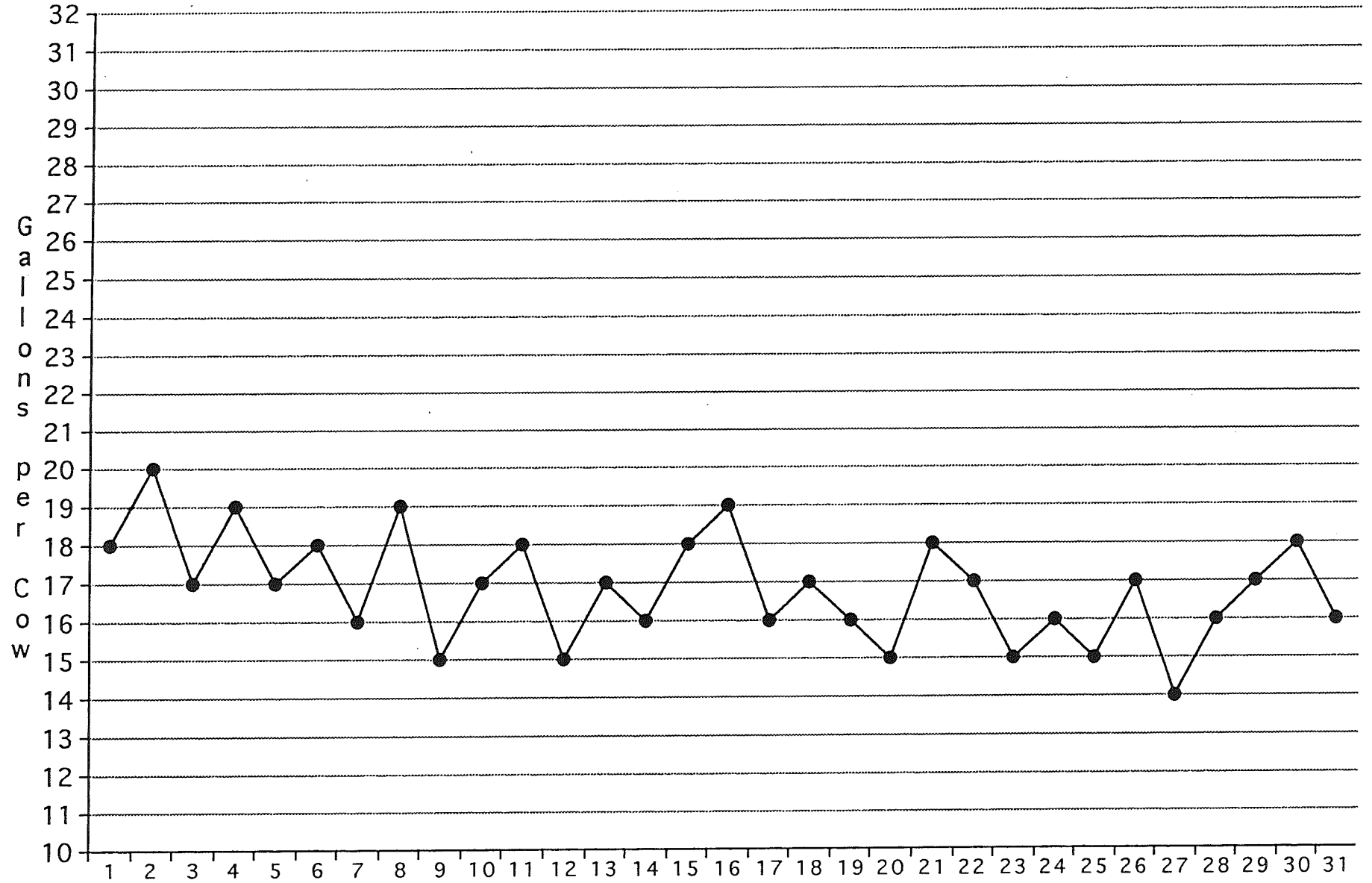
August 1992 Water Meter Readings



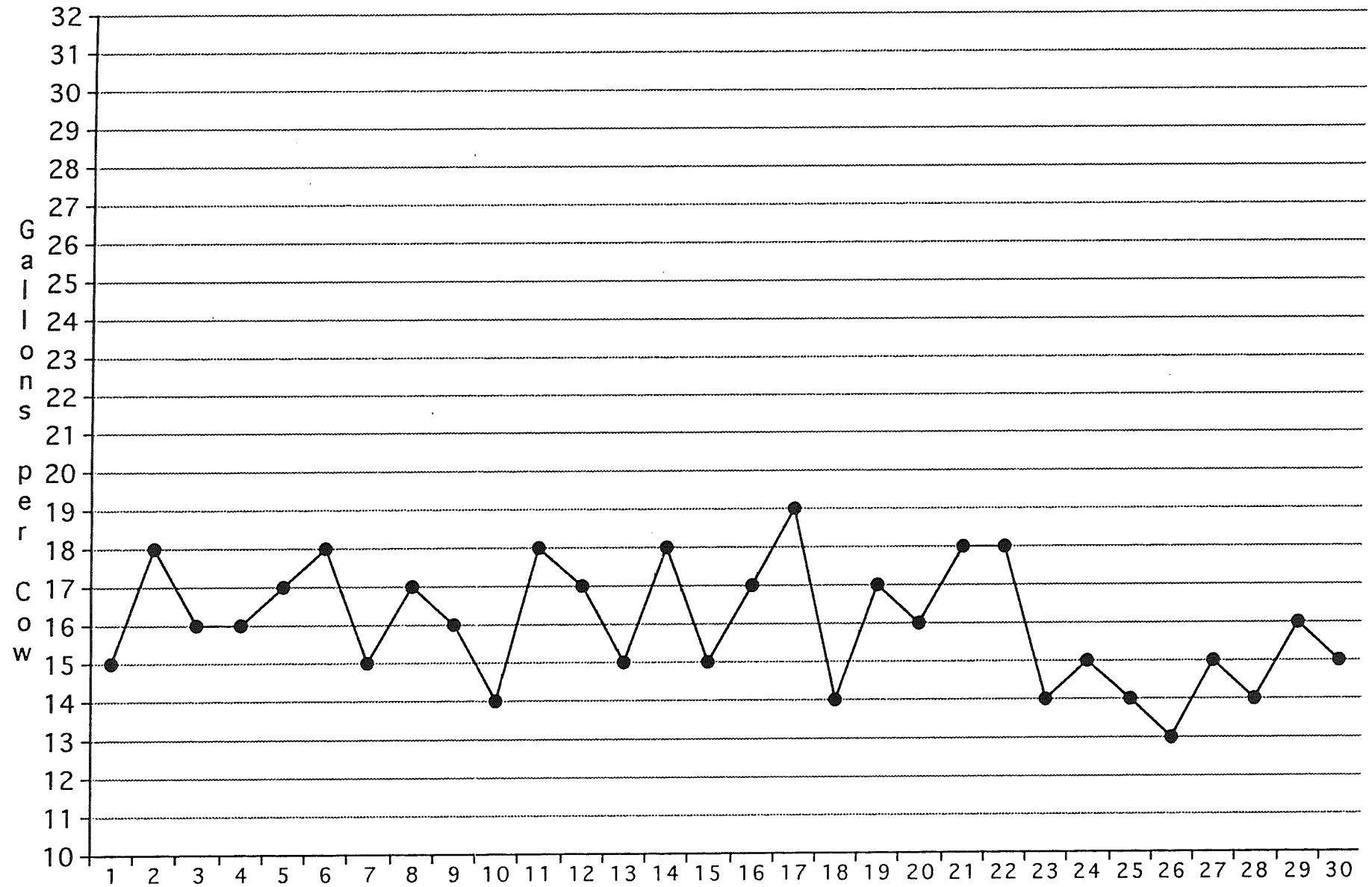
September 1992 Water Meter Readings



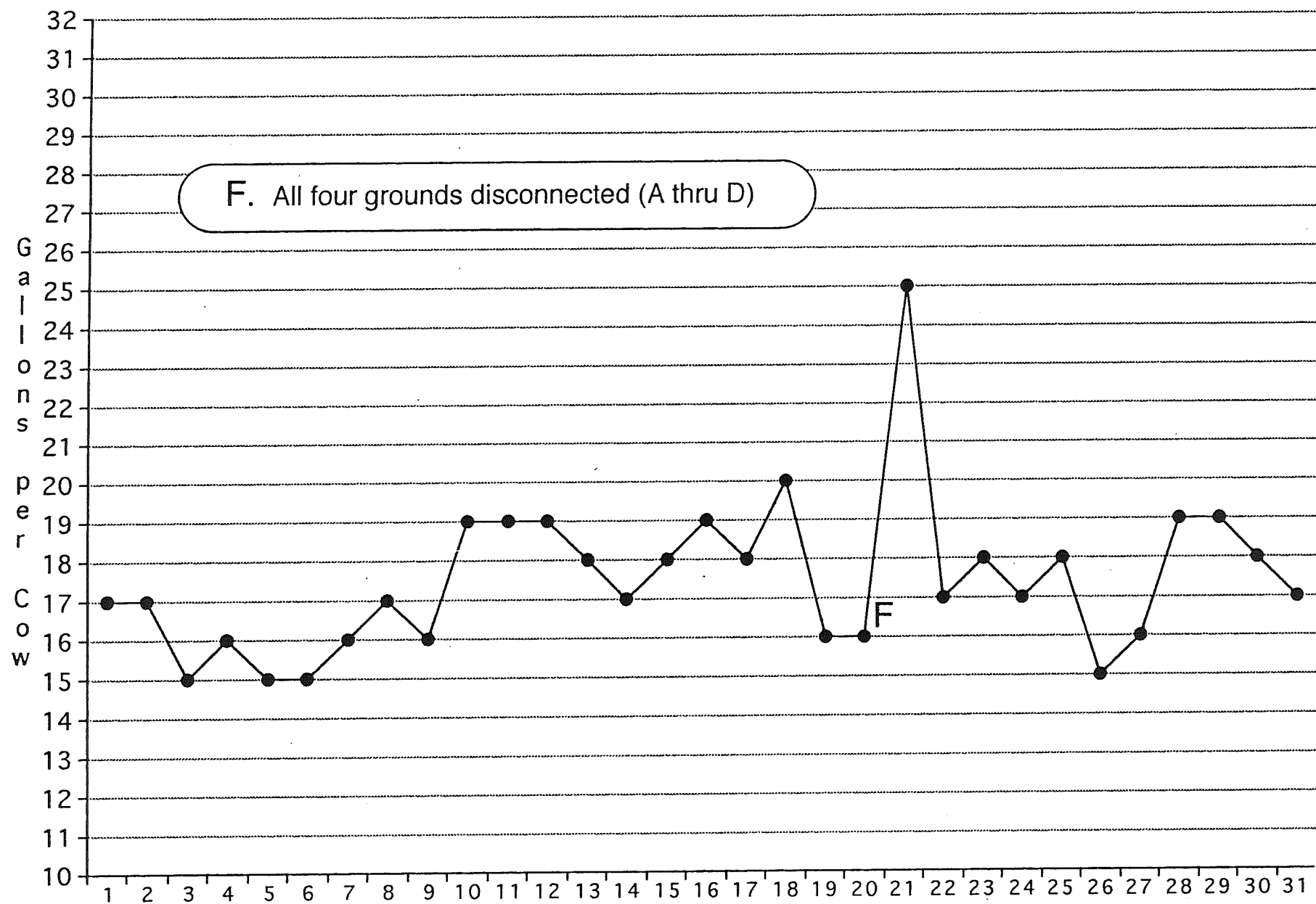
October 1992 Water Meter Readings



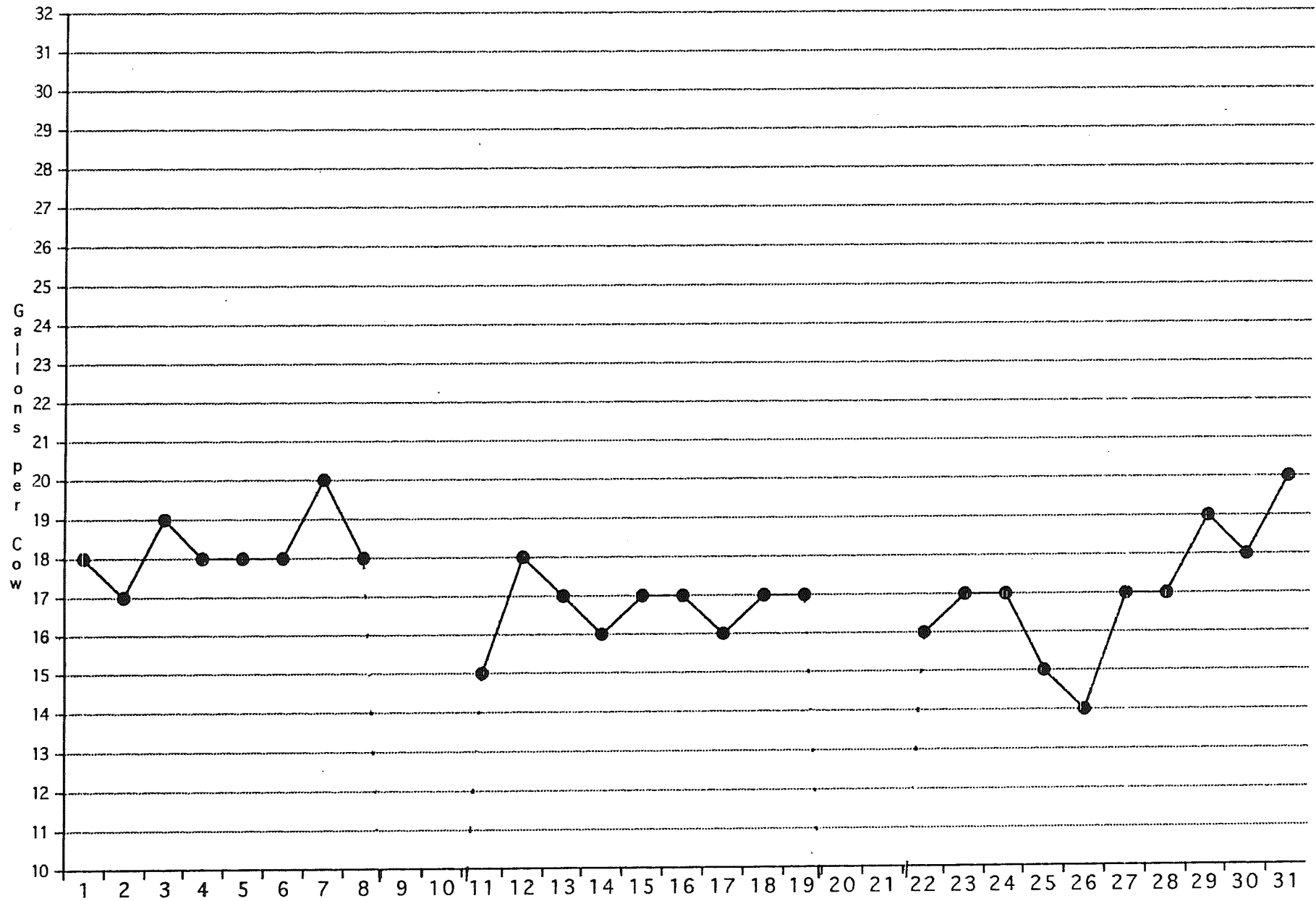
November 1992 Water Meter Readings



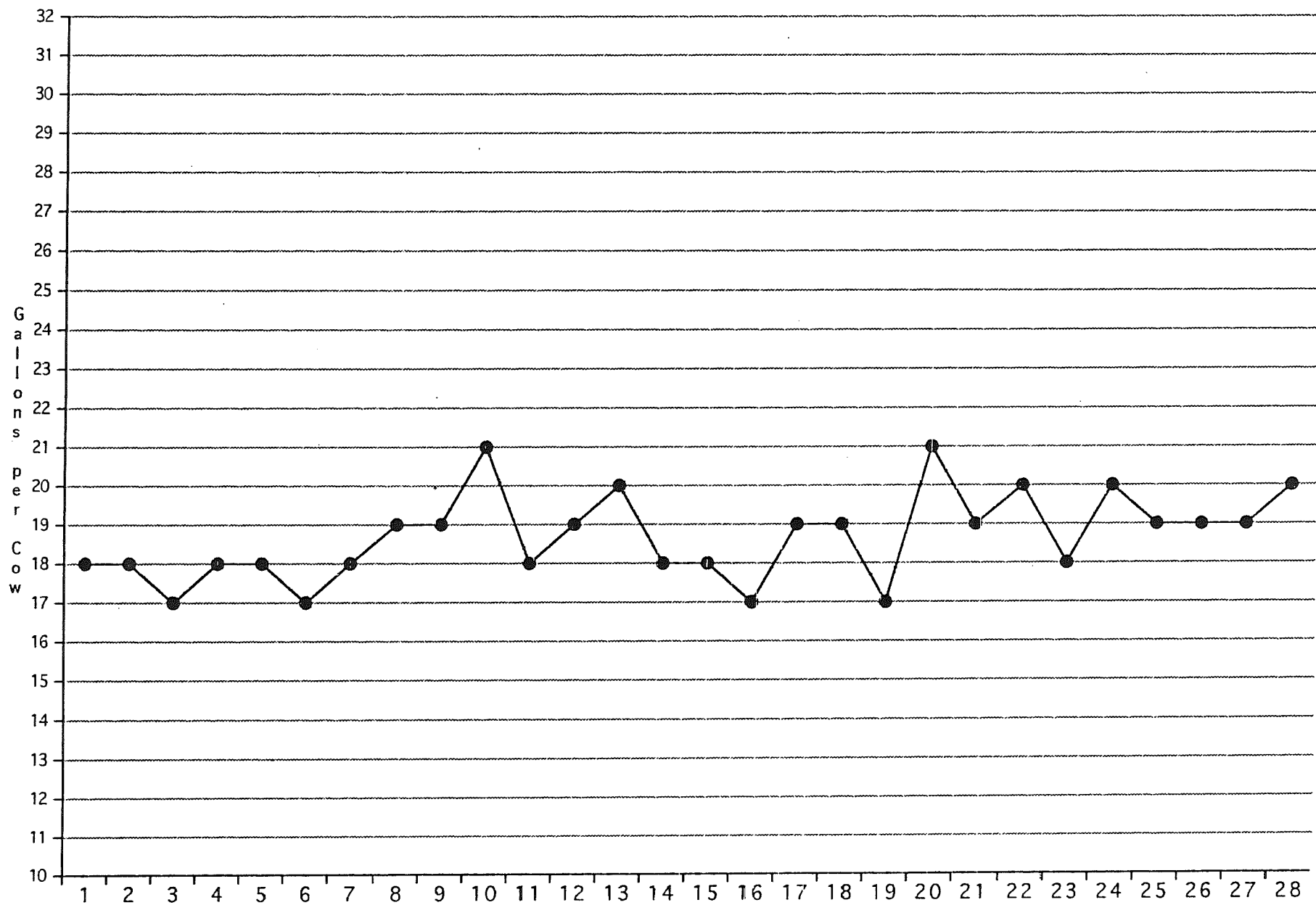
December 1992 Water Meter Readings



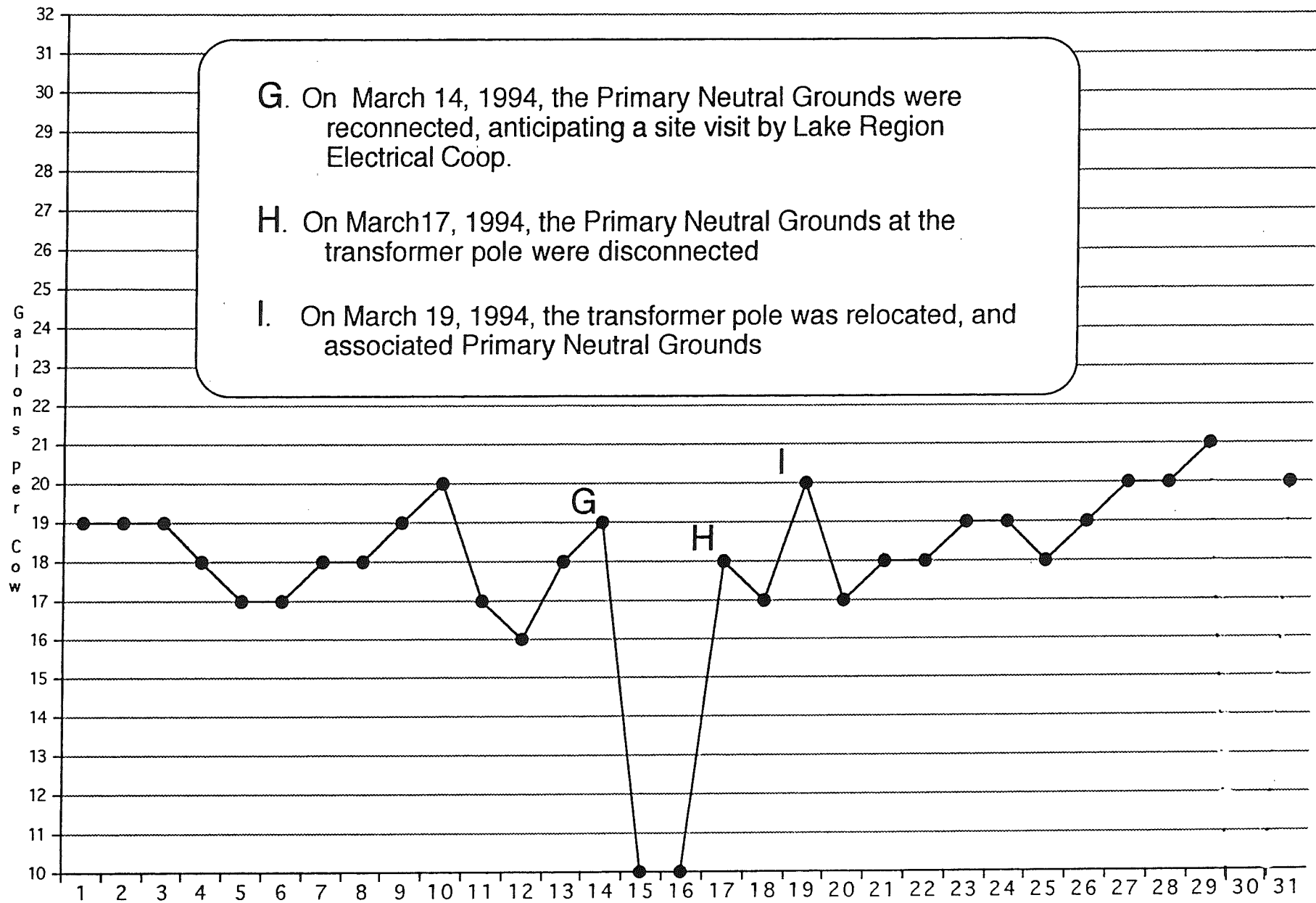
January 1993 Water Meter Readings



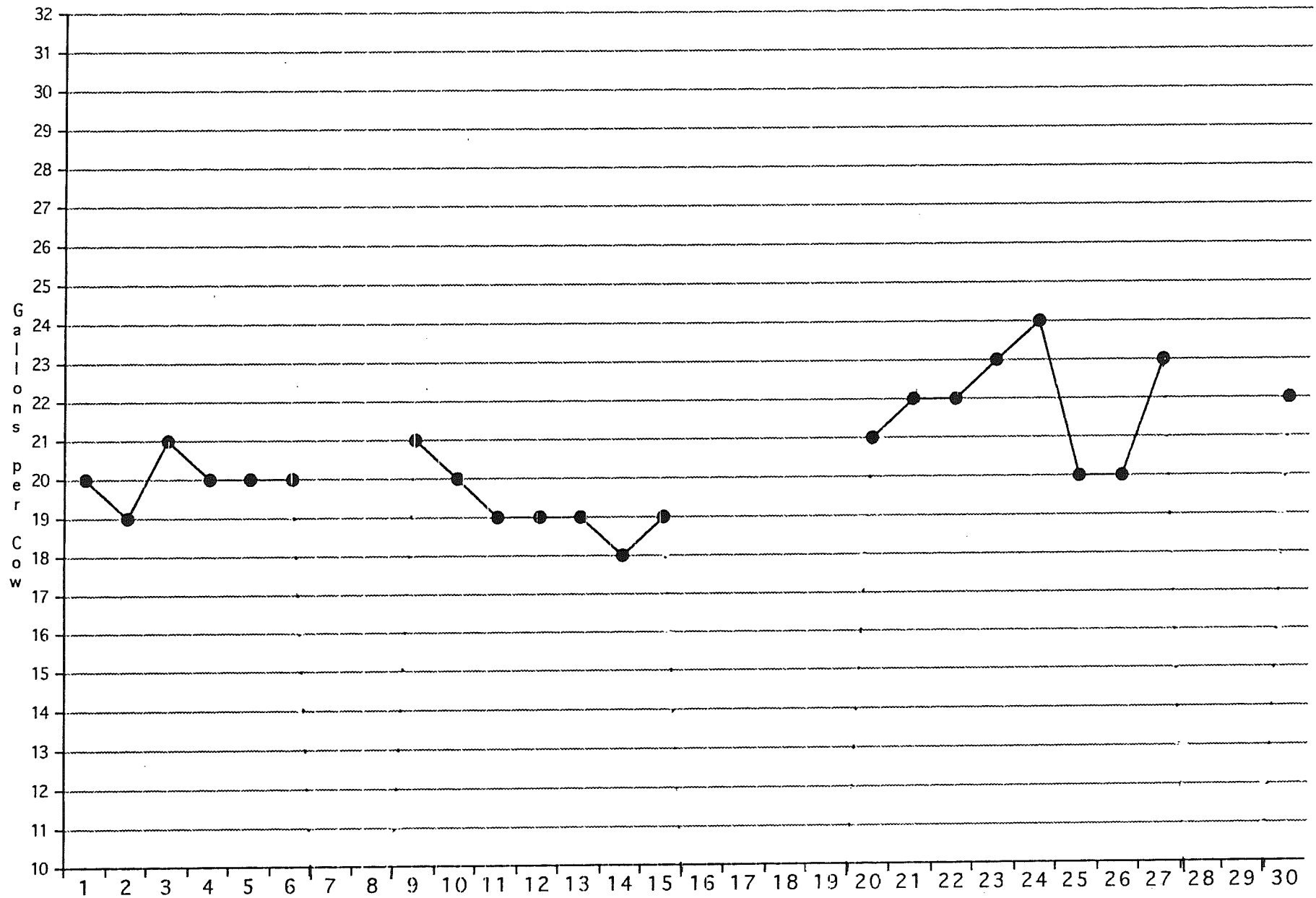
February 1993 Water Meter Readings



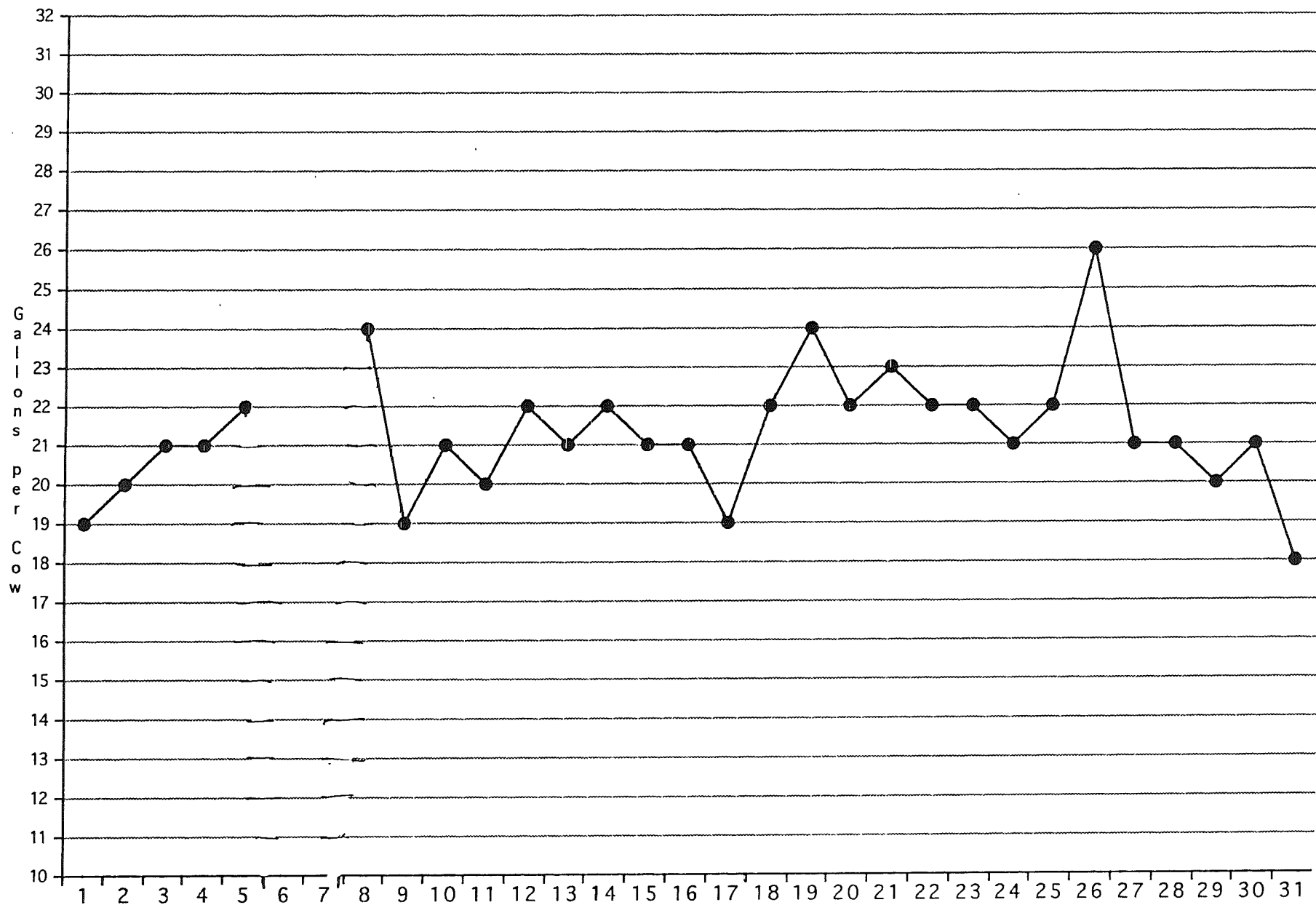
March 1993 Water Meter Readings



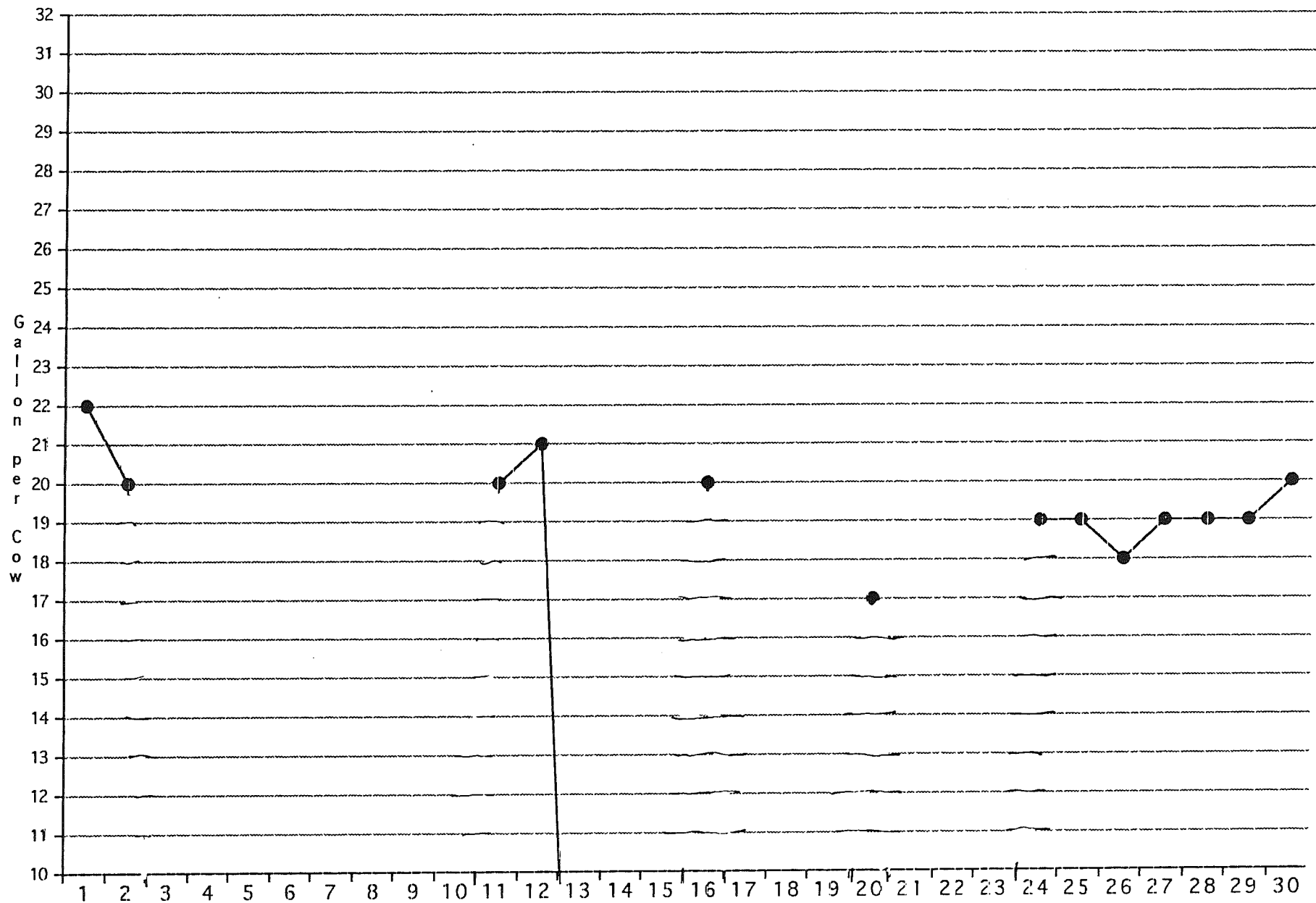
April 1993 Water Meter Readings



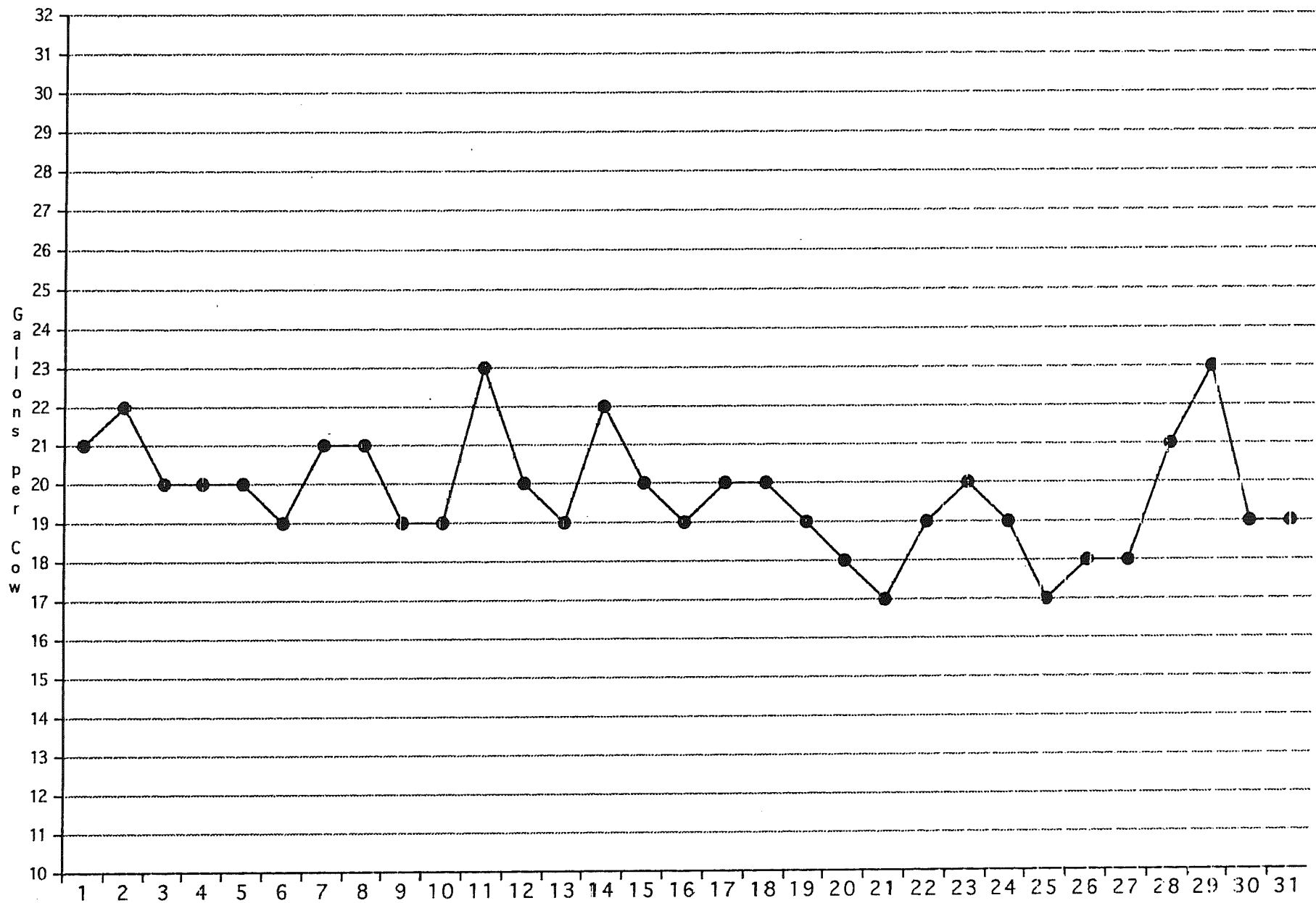
May 1993 Water Meter Readings



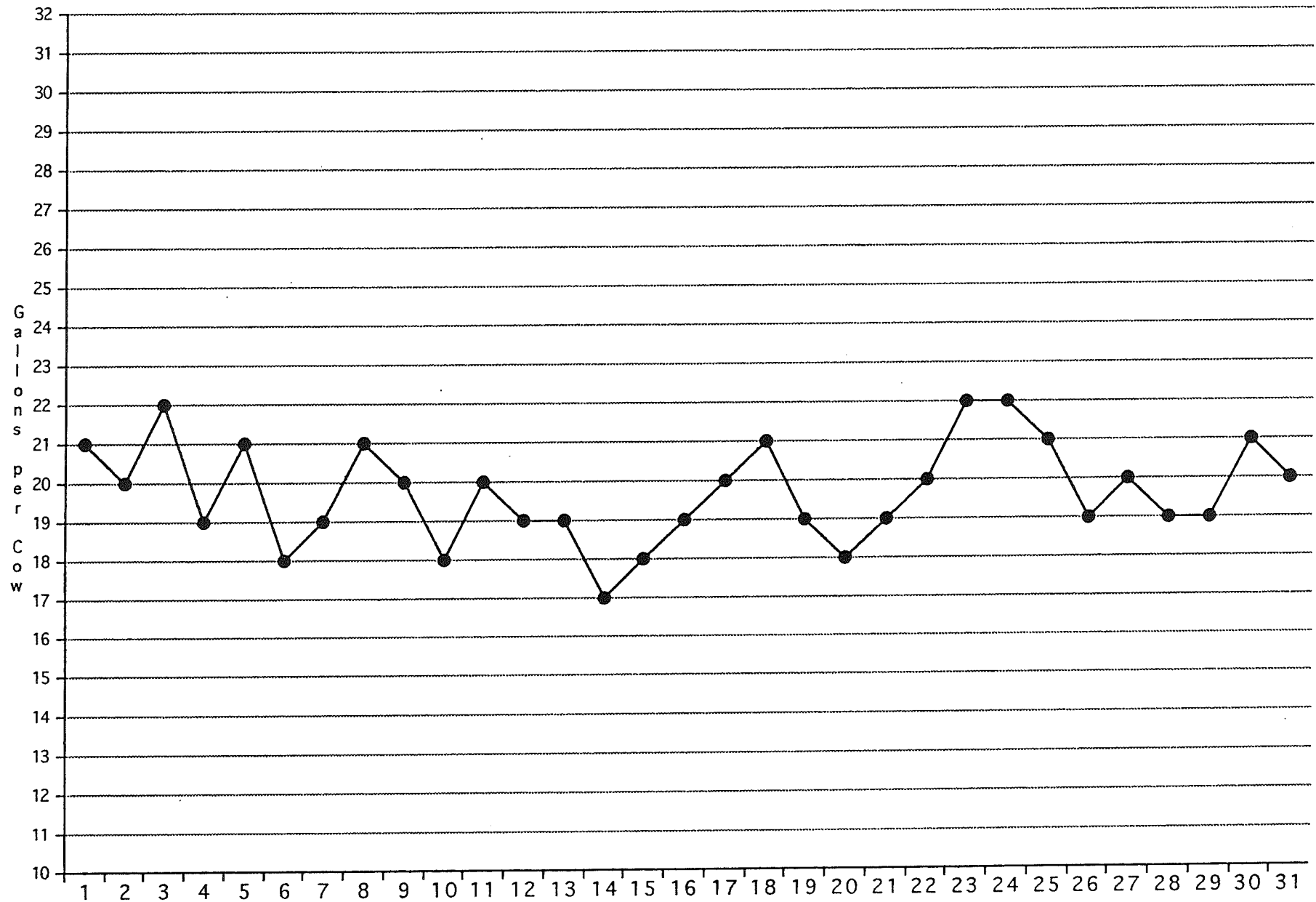
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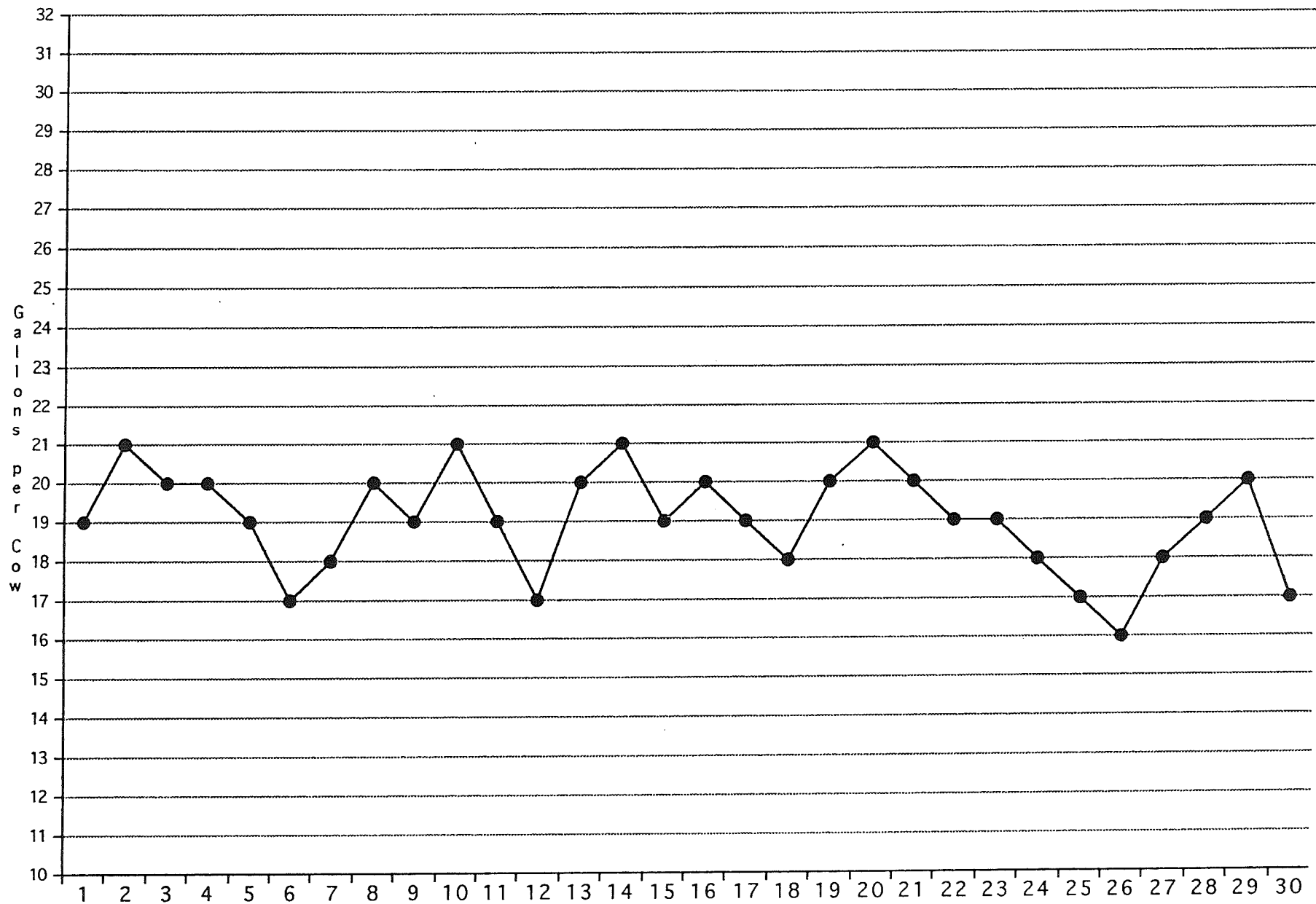
July 1993 Water Meter Readings



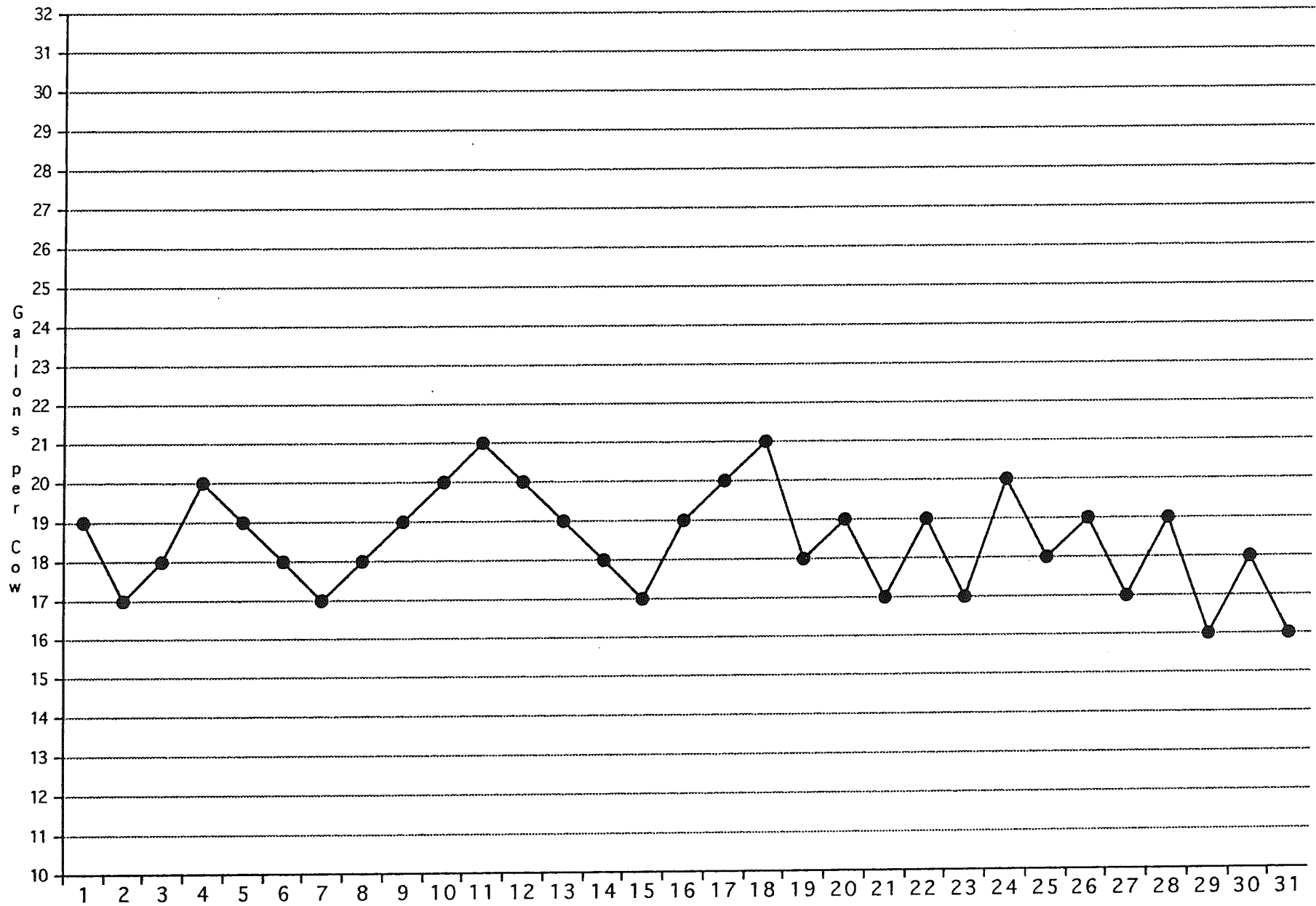
August 1993 Water Meter Readings



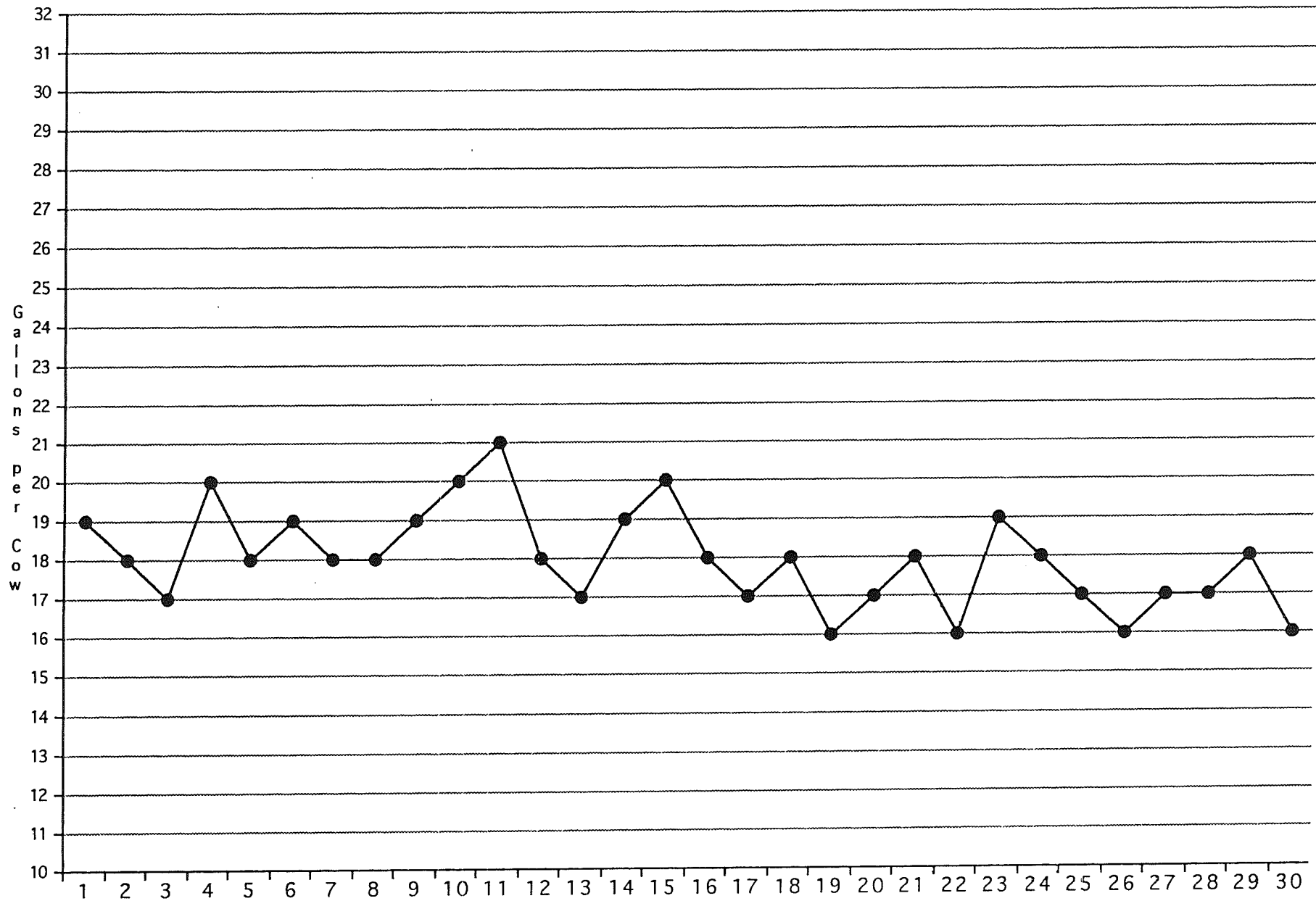
September 1993 Water Meter Readings



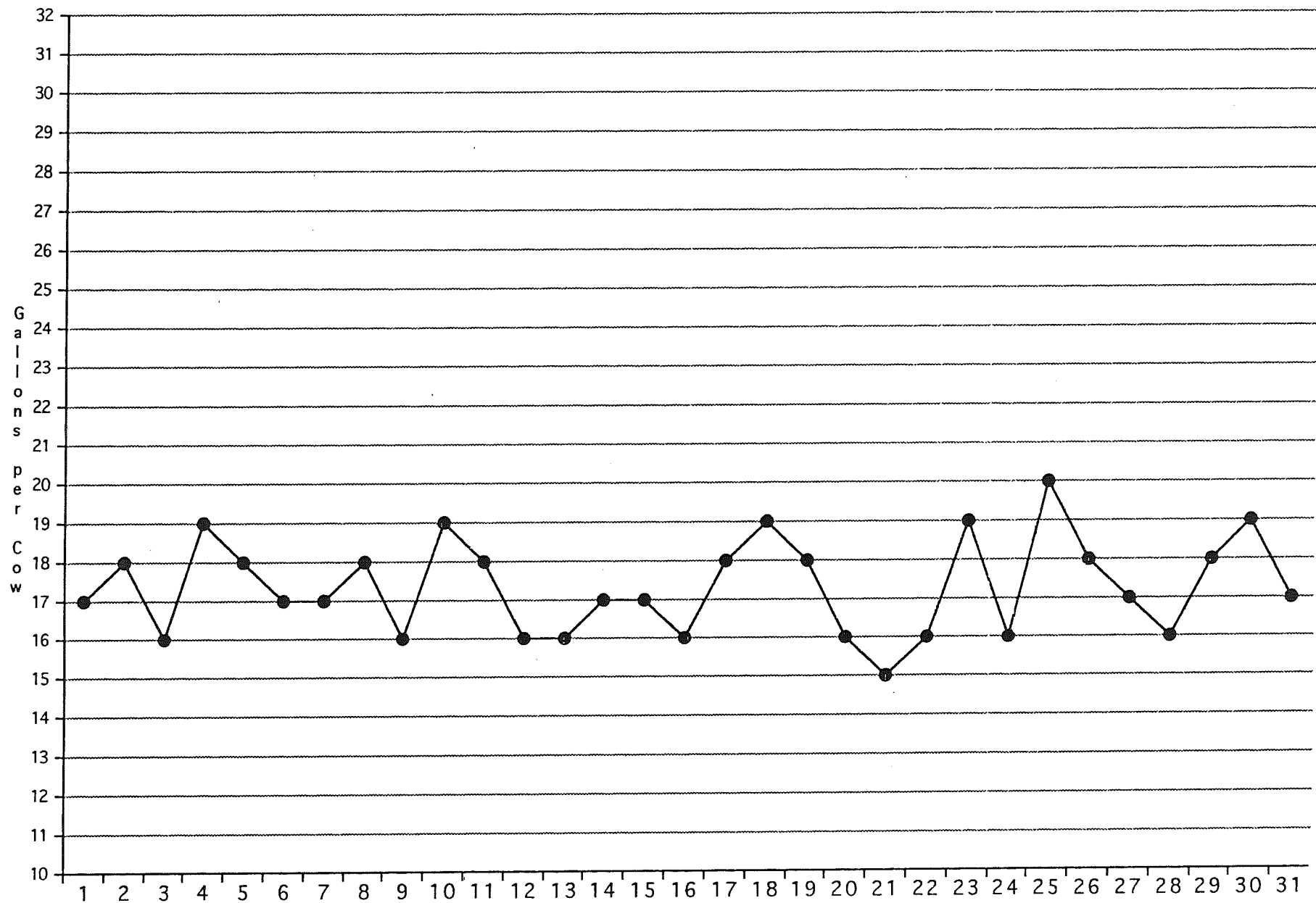
October 1993 Water Meter Readings



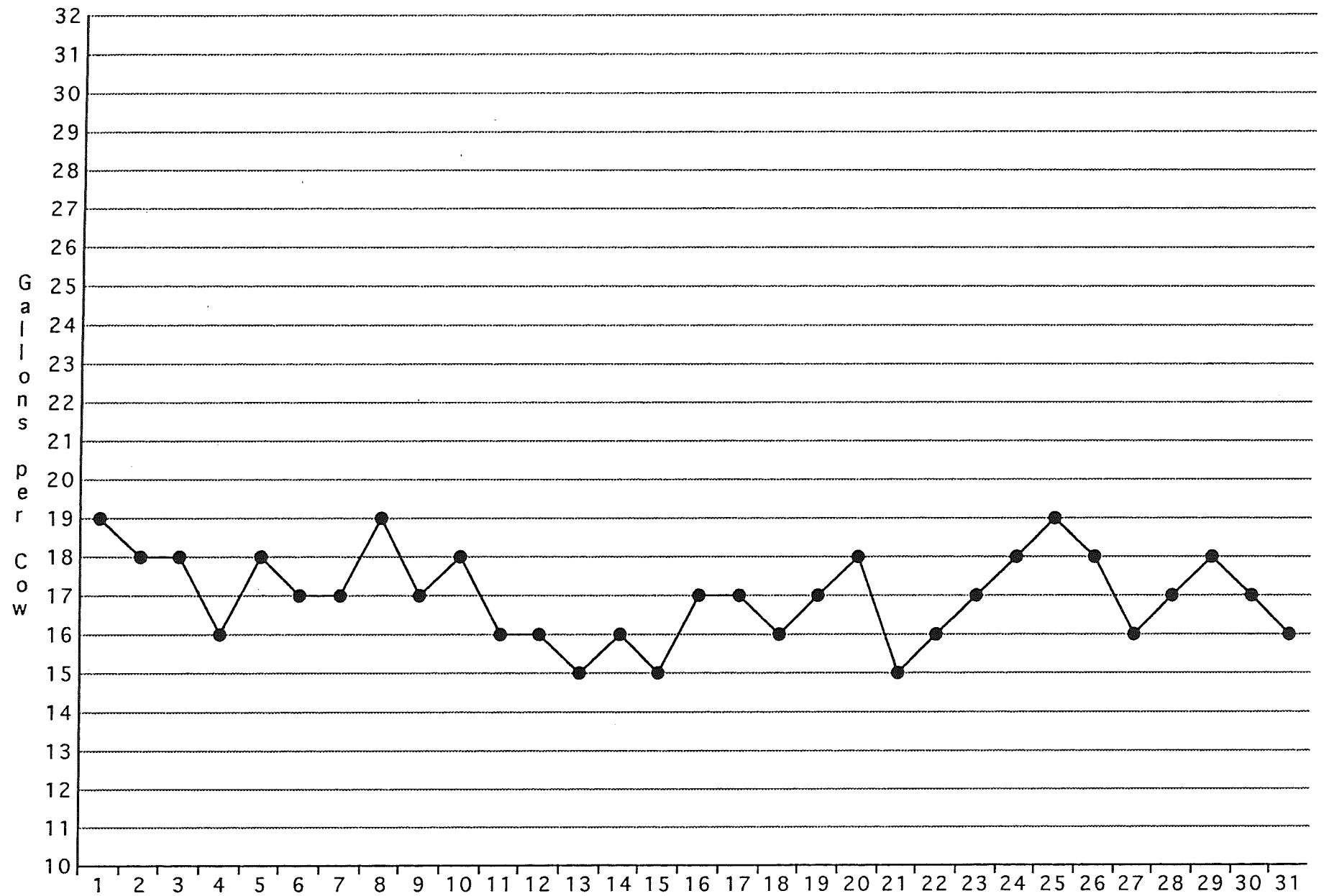
November 1993 Water Meter Readings



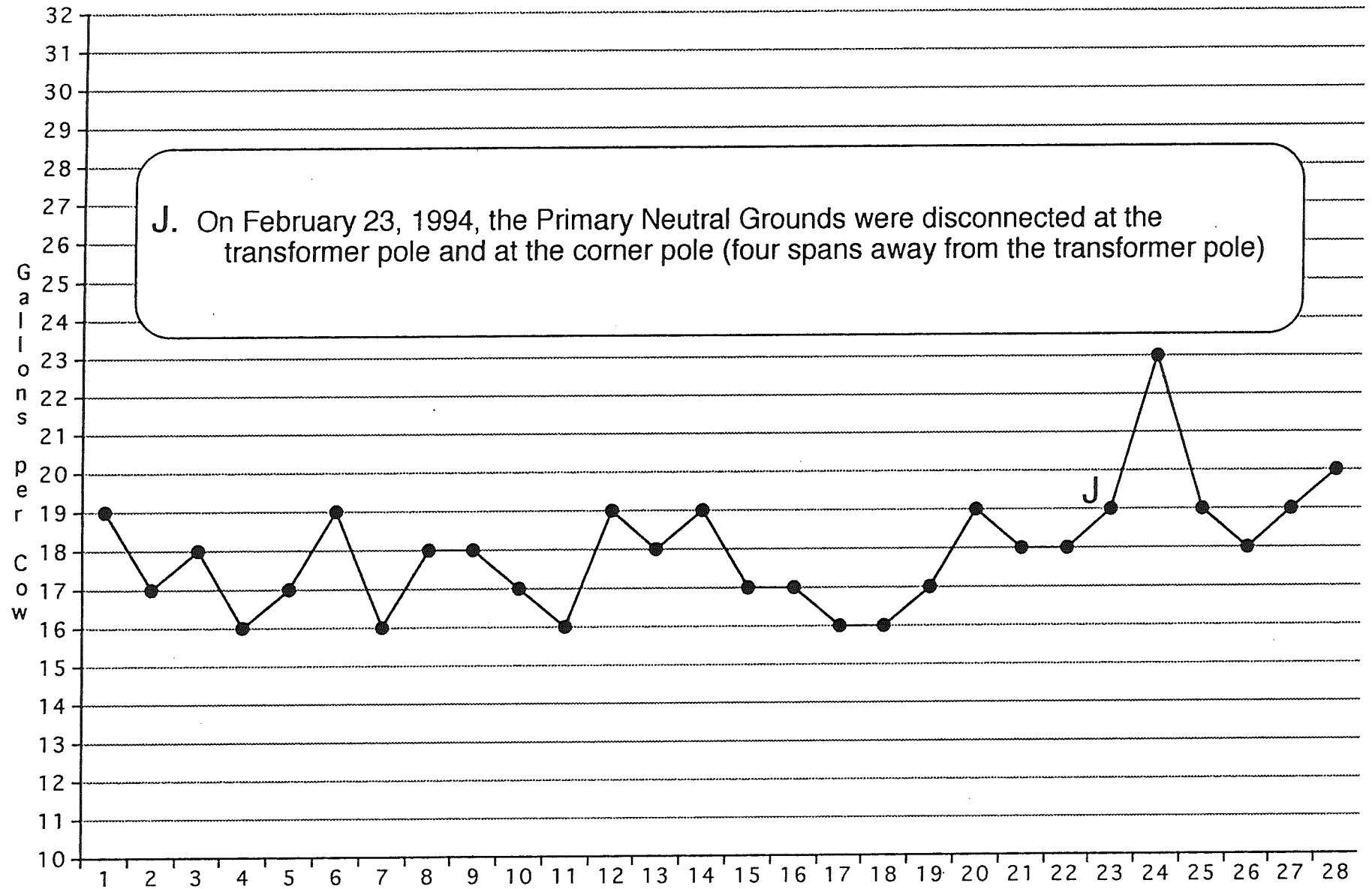
December 1993 Water Meter Readings



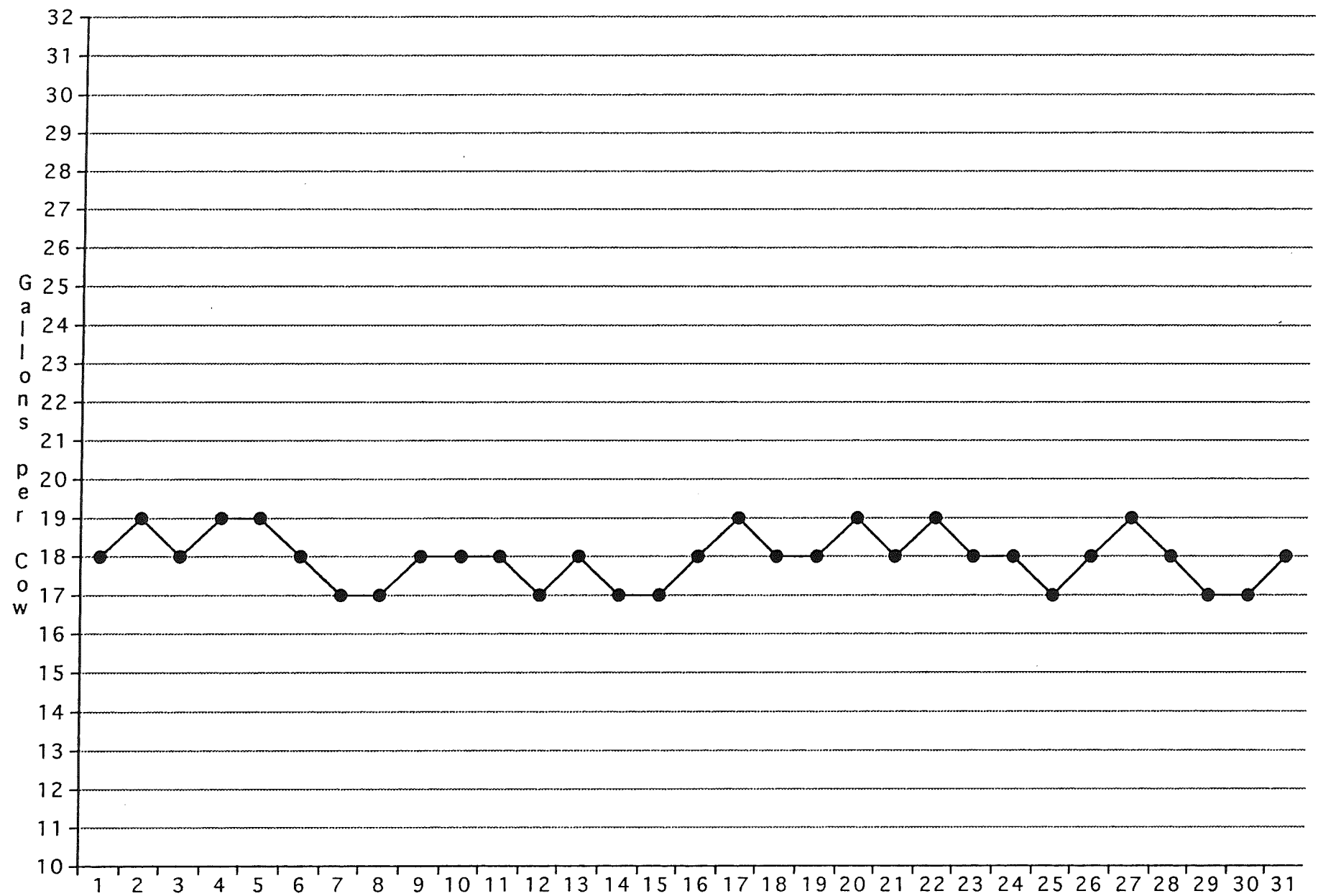
January 1994 Water Meter Readings



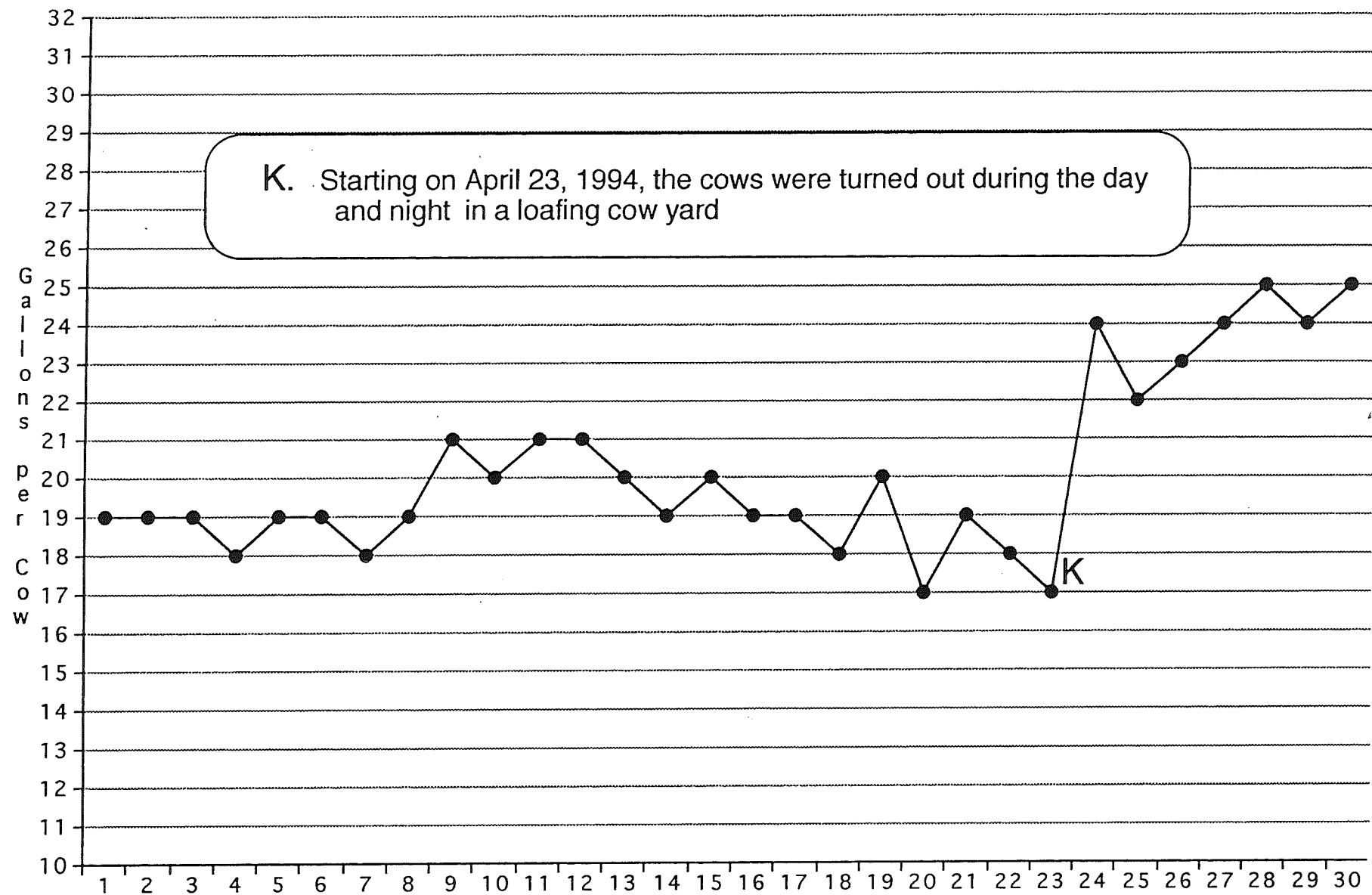
February 1994 Water Meter Readings



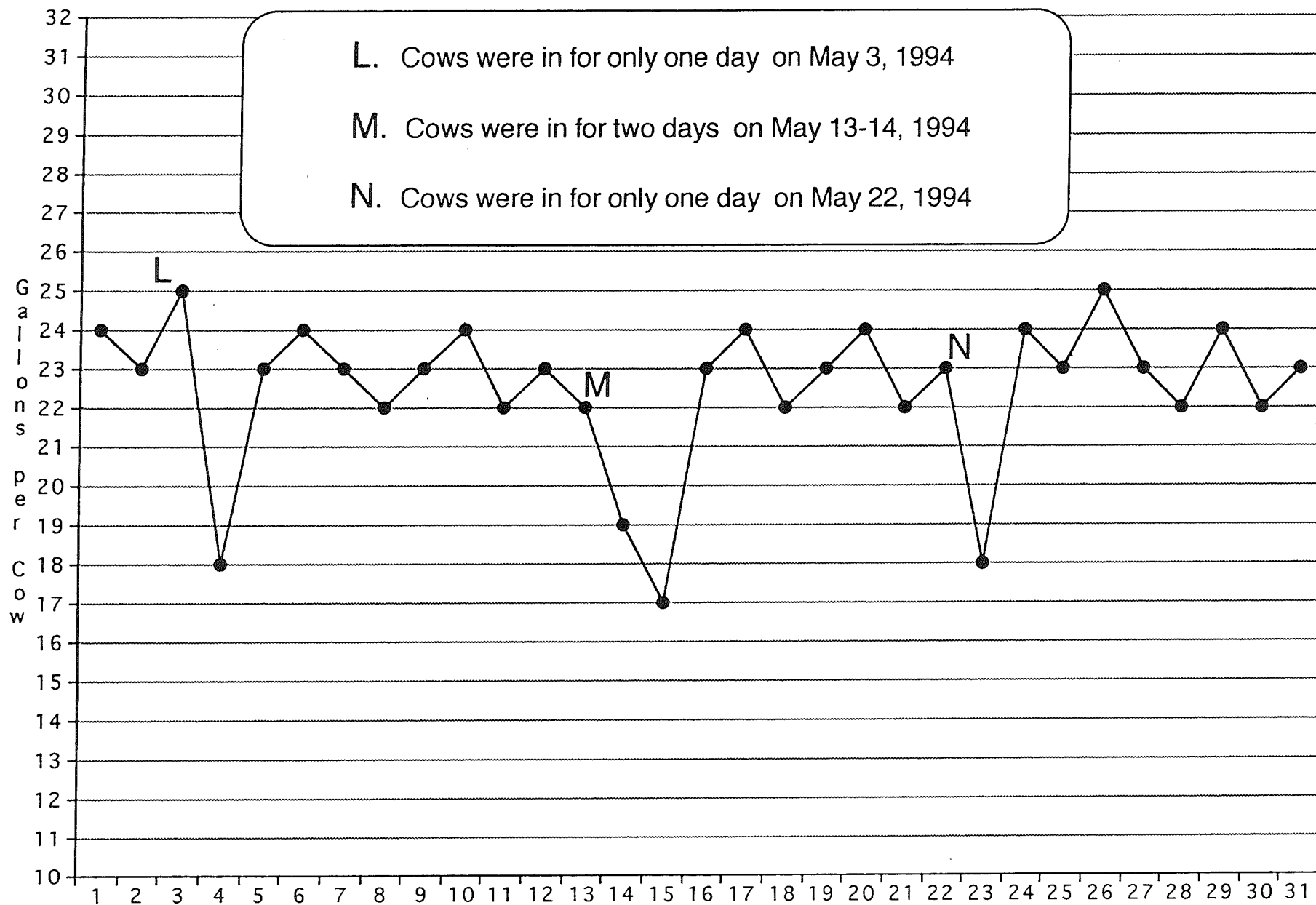
March 1994 Water Meter Readings



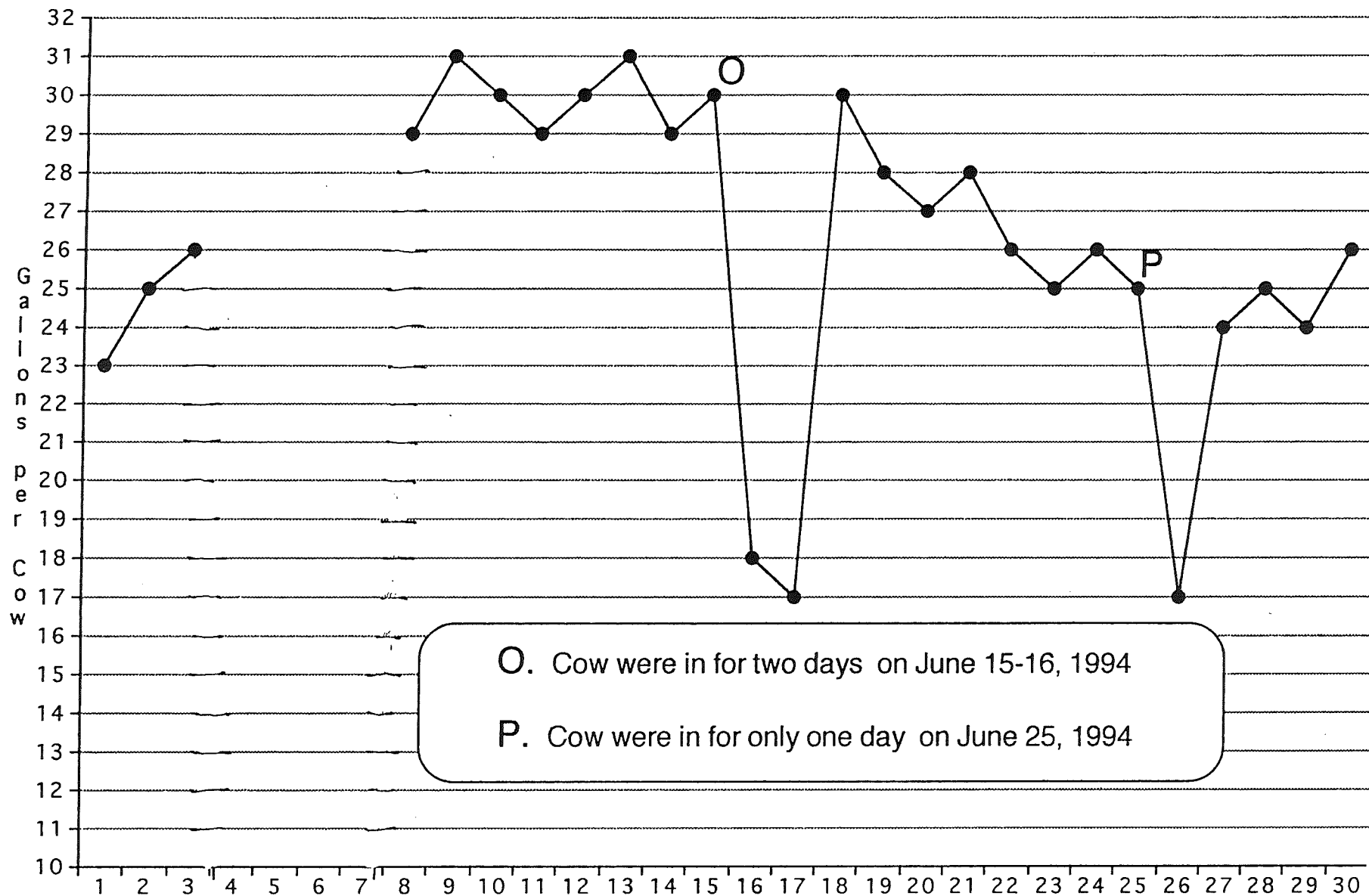
April 1994 Water Meter Readings



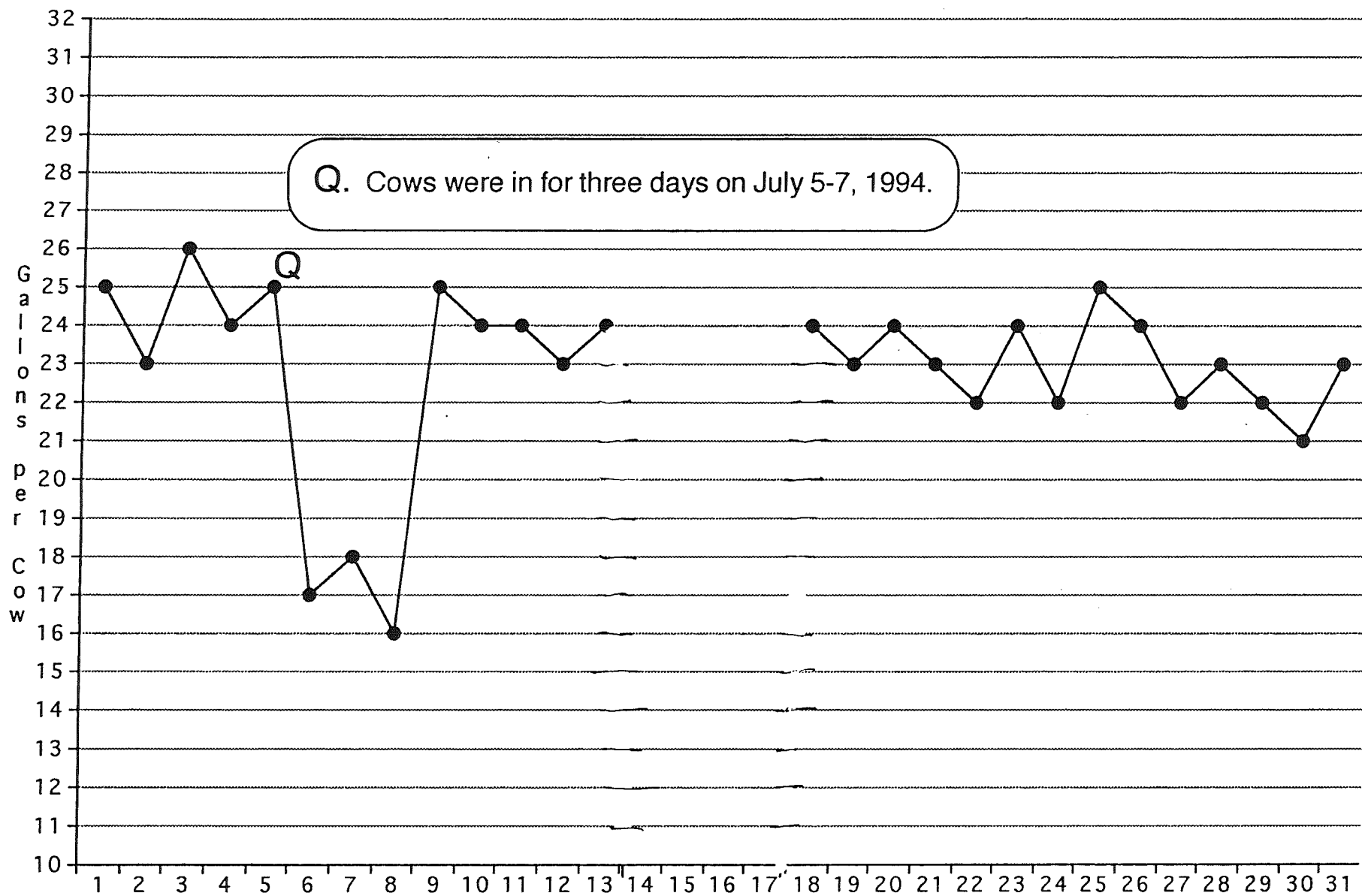
May 1994 Water Meter Readings



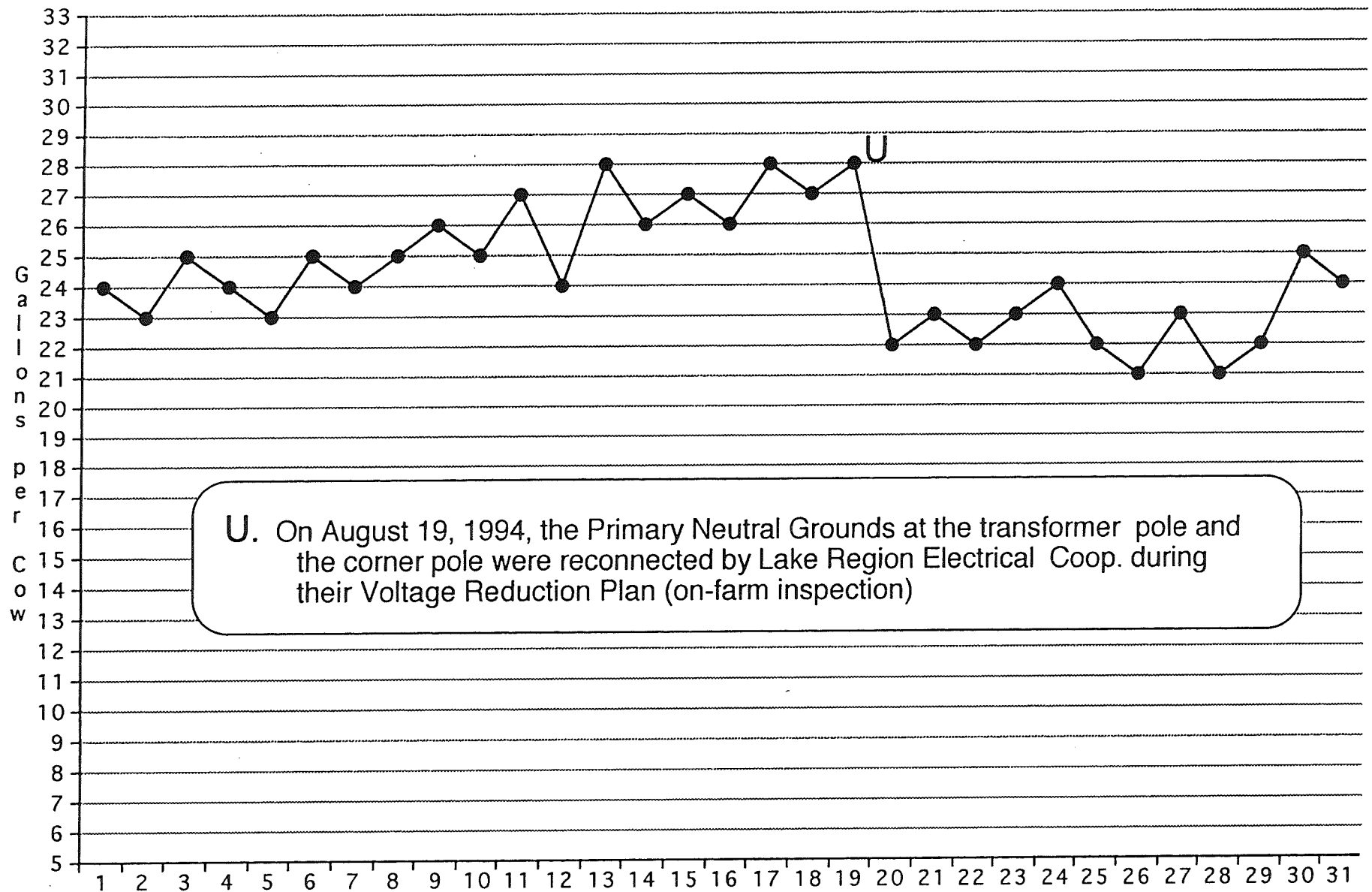
June 1994 Water Meter Readings



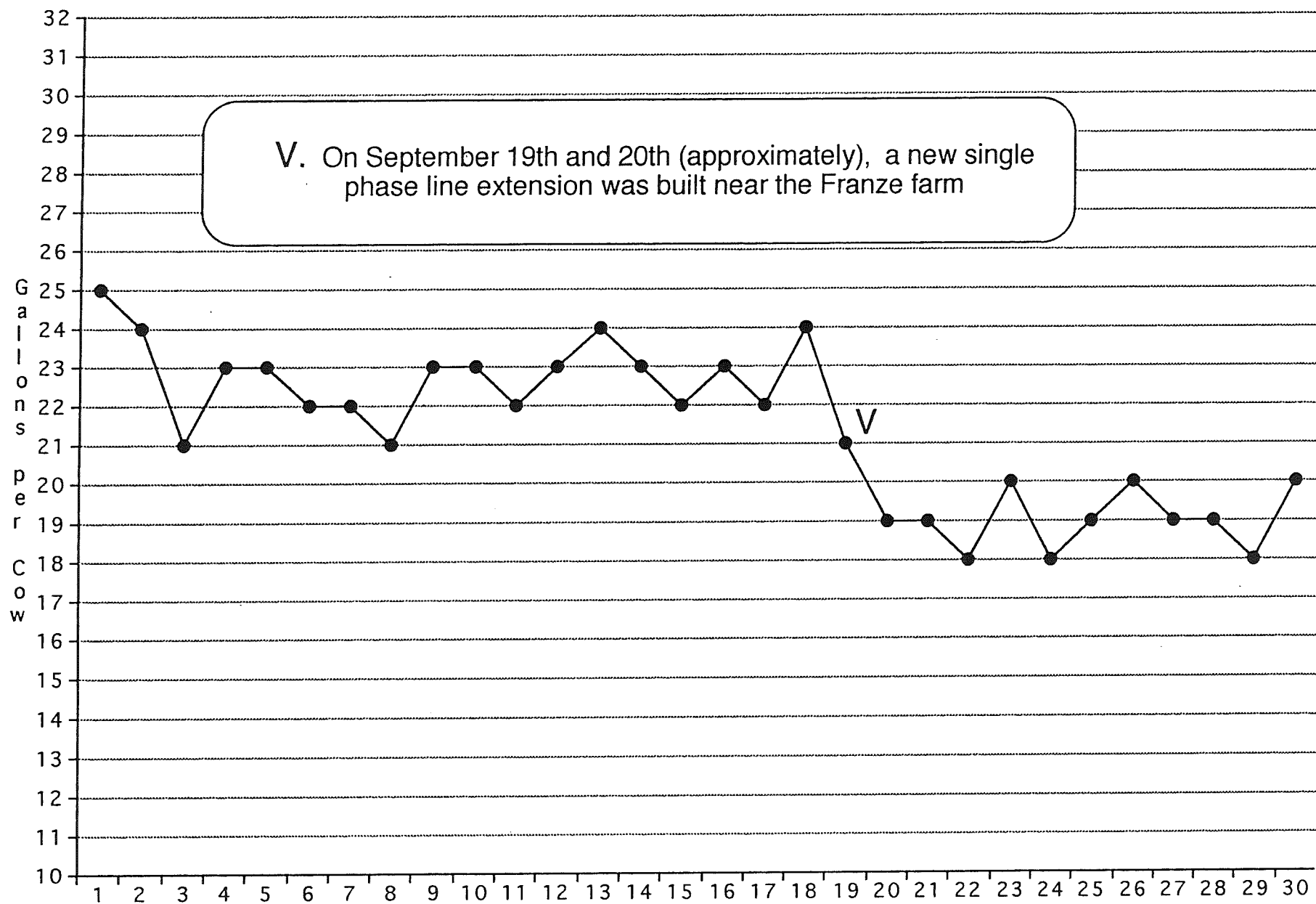
July 1994 Water Meter Readings



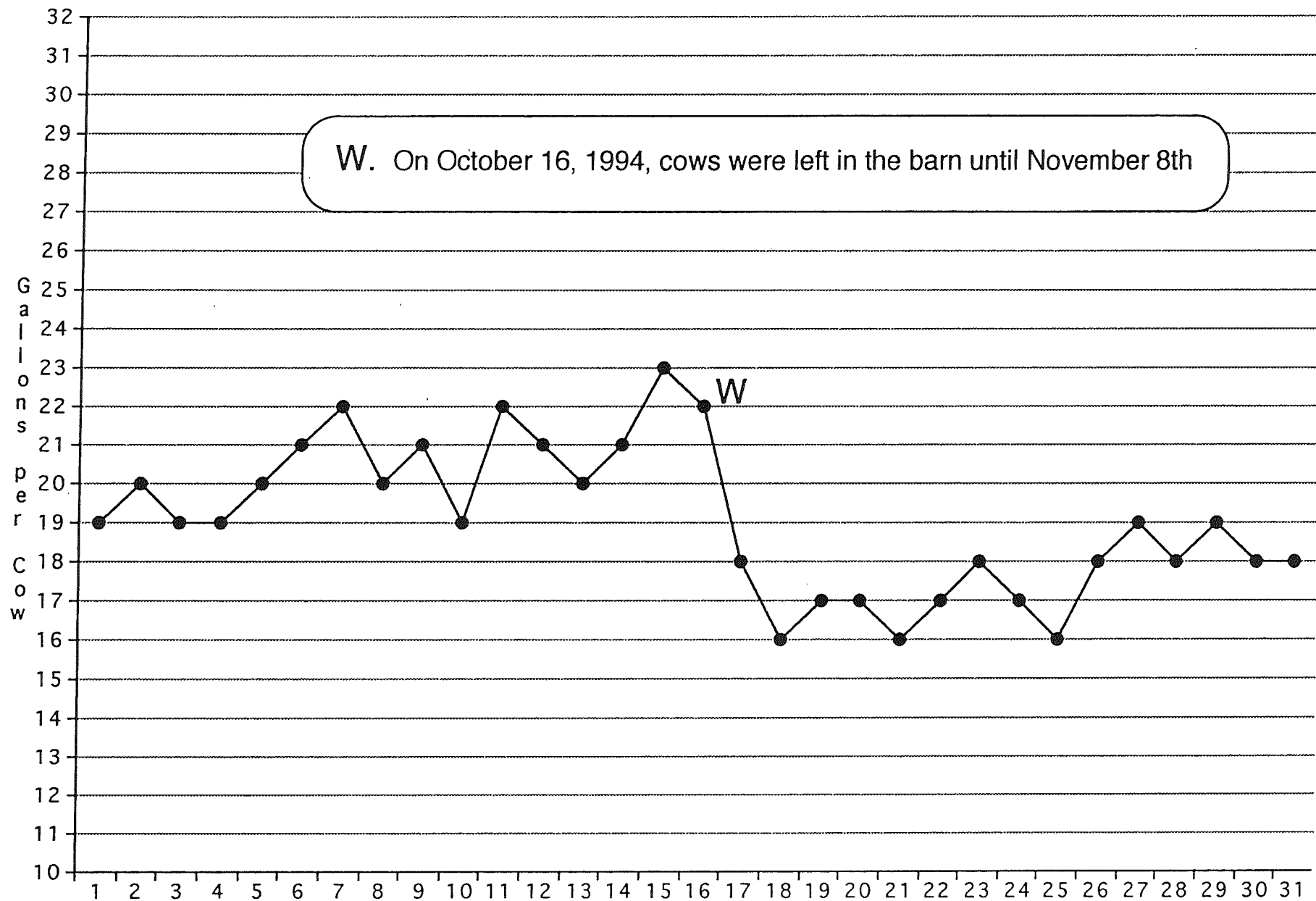
August 1994 Water Meter Readings



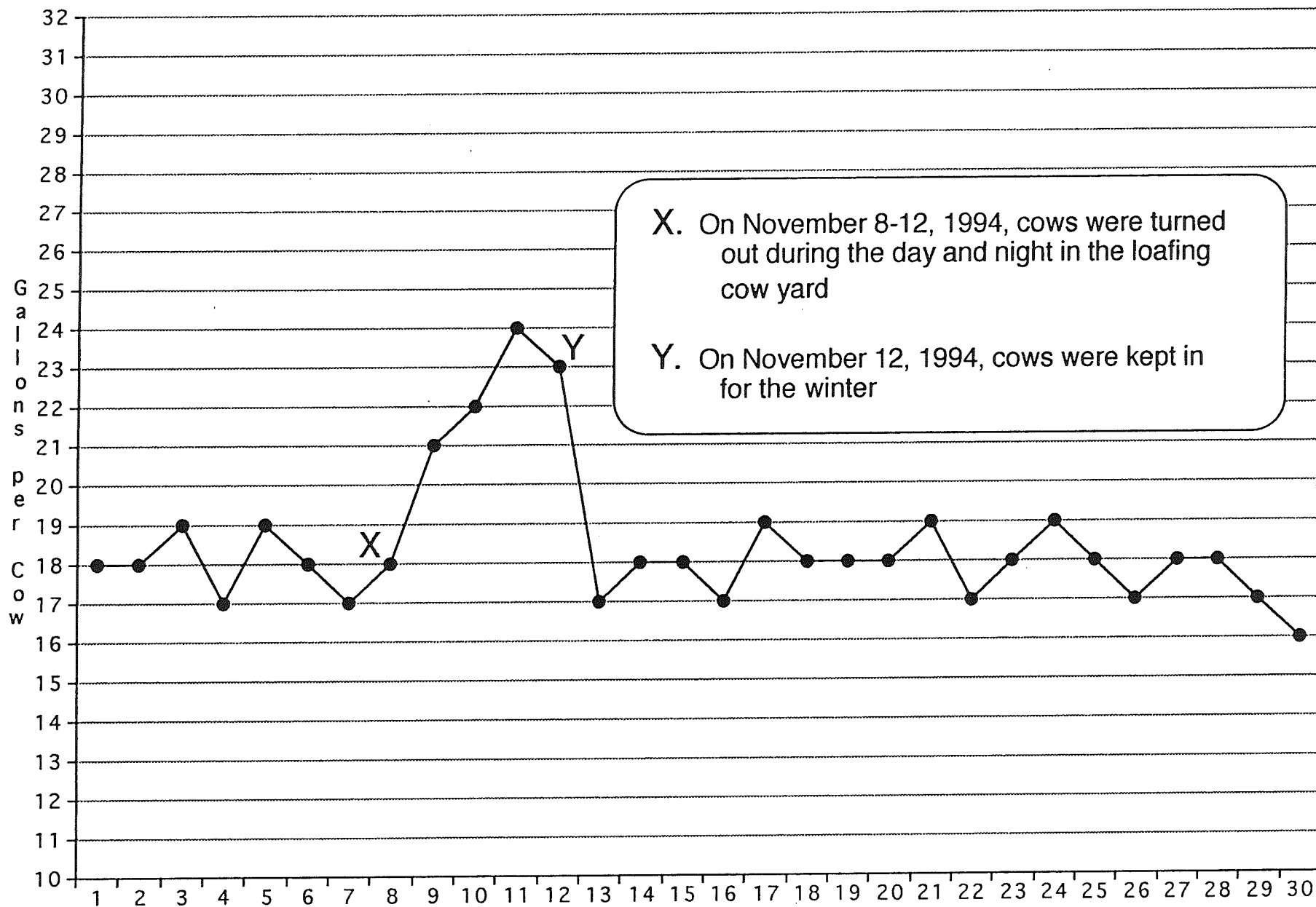
September 1994 Water Meter Readings



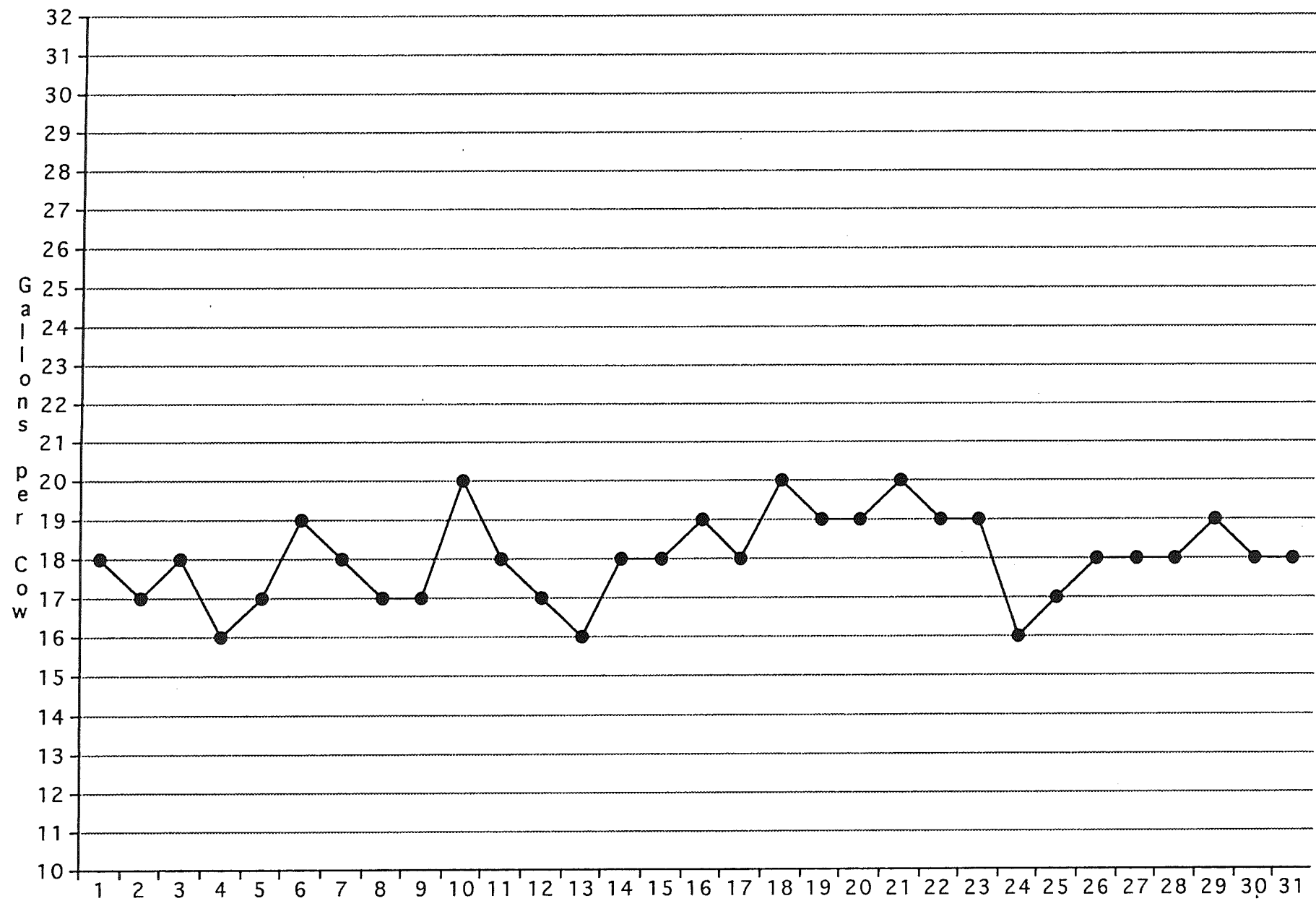
October 1994 Water Meter Readings



November 1994 Water Meter Readings



December 1994 Water Meter Readings



1/29/93	19.00	
1/30/93	18.00	700,000.00
1/31/93	20.00	
2/1/93	18.00	920,000.00
2/2/93	18.00	
2/3/93	17.00	800,000.00
2/4/93	18.00	
2/5/93	18.00	830,000.00
2/6/93	17.00	
2/7/93	18.00	720,000.00
2/8/93	19.00	
2/9/93	19.00	960,000.00
2/10/93	21.00	
2/11/93	18.00	1,000,000.00
2/12/93	19.00	
2/13/93	20.00	751,000.00
2/14/93	18.00	
2/15/93	18.00	820,000.00
2/16/93	17.00	
2/17/93	19.00	830,000.00
2/18/93	19.00	
2/19/93	17.00	910,000.00
2/20/93	21.00	
2/21/93	19.00	860,000.00
2/22/93	20.00	
2/23/93	18.00	820,000.00
2/24/93	20.00	
2/25/93	19.00	
2/26/93	19.00	
2/27/93	19.00	868,000.00
2/28/93	20.00	
3/1/93	19.00	780,000.00
3/2/93	19.00	
3/3/93	19.00	919,000.00
3/4/93	18.00	
3/5/93	17.00	819,000.00
3/6/93	17.00	
3/7/93	18.00	480,000.00
3/8/93	18.00	
3/9/93	19.00	
3/10/93	20.00	
3/11/93	17.00	500,000.00
3/12/93	16.00	
3/13/93	18.00	540,000.00
3/14/93	19.00	
3/15/93	10.00	550,000.00
3/16/93	10.00	
3/17/93	18.00	490,000.00
3/18/93	17.00	
3/19/93	20.00	680,000.00
3/20/93	17.00	

Water Consumption and Somatic Cell Count
on the Franze Farm

Date	Gallons/Cow	Somatic Cell Count
9/19/92		814,000.00
9/21/92		634,000.00
9/23/92		655,000.00
9/25/92		942,000.00
9/29/92		831,000.00
12/1/92		780,000.00
12/3/92		610,000.00
12/5/92		760,000.00
12/7/92		670,000.00
12/9/92		800,000.00
12/11/92		730,000.00
12/13/92		850,000.00
12/15/92		730,000.00
12/17/92		850,000.00
12/19/92		740,000.00
12/21/92		811,000.00
12/23/92		790,000.00
12/25/92		790,000.00
12/27/92		860,000.00
12/29/92		1,100,000.00
12/31/92		1,000,000.00
1/1/93	18.00	
1/2/93	17.00	1,000,000.00
1/3/93	19.00	
1/4/93	18.00	830,000.00
1/5/93	18.00	
1/6/93	18.00	680,000.00
1/7/93	20.00	
1/8/93	18.00	740,000.00
1/9/93	0.00	
1/10/93	0.00	800,000.00
1/11/93	15.00	
1/12/93	18.00	830,000.00
1/13/93	17.00	
1/14/93	16.00	870,000.00
1/15/93	17.00	
1/16/93	17.00	720,000.00
1/17/93	16.00	
1/18/93	17.00	830,000.00
1/19/93	17.00	
1/20/93	0.00	940,000.00
1/21/93	0.00	
1/22/93	16.00	891,000.00
1/23/93	17.00	
1/24/93	17.00	
1/25/93	15.00	
1/26/93	14.00	880,000.00
1/27/93	17.00	
1/28/93	17.00	940,000.00

3/21/93	18.00	740,000.00
3/22/93	18.00	
3/23/93	19.00	670,000.00
3/24/93	19.00	
3/25/93	18.00	600,000.00
3/26/93	19.00	
3/27/93	20.00	700,000.00
3/28/93	20.00	
3/29/93	21.00	770,000.00
3/30/93	0.00	
3/31/93	20.00	660,000.00
4/1/93	20.00	
4/2/93	19.00	610,000.00
4/3/93	21.00	
4/4/93	20.00	750,000.00
4/5/93	20.00	
4/6/93	20.00	620,000.00
4/7/93	0.00	
4/8/93	0.00	470,000.00
4/9/93	21.00	
4/10/93	20.00	650,000.00
4/11/93	19.00	
4/12/93	19.00	470,000.00
4/13/93	19.00	
4/14/93	18.00	560,000.00
4/15/93	19.00	
4/16/93	0.00	520,000.00
4/17/93	0.00	
4/18/93	0.00	470,000.00
4/19/93	0.00	
4/20/93	21.00	670,000.00
4/21/93	22.00	
4/22/93	22.00	520,000.00
4/23/93	23.00	
4/24/93	24.00	680,000.00
4/25/93	20.00	
4/26/93	20.00	660,000.00
4/27/93	23.00	
4/28/93	0.00	
4/29/93	0.00	
4/30/93	22.00	
5/1/93	19.00	
5/2/93	20.00	620,000.00
5/3/93	21.00	
5/4/93	21.00	610,000.00
5/5/93	22.00	
5/6/93	0.00	540,000.00
5/7/93	0.00	
5/8/93	24.00	520,000.00
5/9/93	19.00	
5/10/93	21.00	570,000.00

5/11/93	20.00	
5/12/93	22.00	500,000.00
5/13/93	21.00	
5/14/93	22.00	570,000.00
5/15/93	21.00	
5/16/93	21.00	540,000.00
5/17/93	19.00	
5/18/93	22.00	600,000.00
5/19/93	24.00	
5/20/93	22.00	680,000.00
5/21/93	23.00	
5/22/93	22.00	680,000.00
5/23/93	22.00	
5/24/93	21.00	720,000.00
5/25/93	22.00	
5/26/93	26.00	820,000.00
5/27/93	21.00	
5/28/93	21.00	
5/29/93	20.00	
5/30/93	21.00	670,000.00
5/31/93	18.00	
6/1/93	22.00	560,000.00
6/2/93	20.00	
6/3/93	0.00	800,000.00
6/4/93	0.00	
6/5/93	0.00	660,000.00
6/6/93	0.00	
6/7/93	0.00	570,000.00
6/8/93	0.00	
6/9/93	0.00	710,000.00
6/10/93	0.00	
6/11/93	20.00	660,000.00
6/12/93	21.00	
6/13/93	0.00	670,000.00
6/14/93	0.00	
6/15/93	0.00	760,000.00
6/16/93	20.00	
6/17/93	0.00	690,000.00
6/18/93	0.00	
6/19/93	0.00	770,000.00
6/20/93	17.00	
6/21/93	0.00	760,000.00
6/22/93	0.00	
6/23/93	0.00	680,000.00
6/24/93	19.00	
6/25/93	19.00	660,000.00
6/26/93	18.00	
6/27/93	19.00	710,000.00
6/28/93	19.00	
6/29/93	19.00	650,000.00
6/30/93	20.00	

7/1/93	21.00	640,000.00
7/2/93	22.00	
7/3/93	20.00	780,000.00
7/4/93	20.00	
7/5/93	20.00	620,000.00
7/6/93	19.00	
7/7/93	21.00	660,000.00
7/8/93	21.00	
7/9/93	19.00	690,000.00
7/10/93	19.00	
7/11/93	23.00	700,000.00
7/12/93	20.00	
7/13/93	19.00	680,000.00
7/14/93	22.00	
7/15/93	20.00	720,000.00
7/16/93	19.00	
7/17/93	20.00	790,000.00
7/18/93	20.00	
7/19/93	19.00	560,000.00
7/20/93	18.00	
7/21/93	17.00	470,000.00
7/22/93	19.00	
7/23/93	20.00	580,000.00
7/24/93	19.00	
7/25/93	17.00	680,000.00
7/26/93	18.00	
7/27/93	18.00	620,000.00
7/28/93	21.00	
7/29/93	23.00	550,000.00
7/30/93	19.00	
7/31/93	19.00	620,000.00
8/1/93	21.00	
8/2/93	20.00	730,000.00
8/3/93	22.00	
8/4/93	19.00	600,000.00
8/5/93	21.00	
8/6/93	18.00	580,000.00
8/7/93	19.00	
8/8/93	21.00	700,000.00
8/9/93	20.00	
8/10/93	18.00	690,000.00
8/11/93	20.00	
8/12/93	19.00	630,000.00
8/13/93	19.00	
8/14/93	17.00	680,000.00
8/15/93	18.00	
8/16/93	19.00	640,000.00
8/17/93	20.00	
8/18/93	21.00	730,000.00
8/19/93	19.00	
8/20/93	18.00	840,000.00

Water Consumption and Somatic Cell Count
on the Franze Farm

8/21/93	19.00	
8/22/93	20.00	830,000.00
8/23/93	22.00	
8/24/93	22.00	870,000.00
8/25/93	21.00	
8/26/93	19.00	1,000,000.00
8/27/93	20.00	1,000,000.00
8/28/93	19.00	
8/29/93	19.00	1,000,000.00
8/30/93	21.00	
8/31/93	20.00	1,100,000.00
9/1/93	19.00	
9/2/93	21.00	660,000.00
9/3/93	20.00	
9/4/93	20.00	780,000.00
9/5/93	19.00	
9/6/93	17.00	940,000.00
9/7/93	18.00	
9/8/93	20.00	760,000.00
9/9/93	19.00	
9/10/93	21.00	660,000.00
9/11/93	19.00	
9/12/93	17.00	
9/13/93	20.00	
9/14/93	21.00	900,000.00
9/15/93	19.00	
9/16/93	20.00	860,000.00
9/17/93	19.00	
9/18/93	18.00	790,000.00
9/19/93	20.00	
9/20/93	21.00	870,000.00
9/21/93	20.00	
9/22/93	19.00	890,000.00
9/23/93	19.00	740,000.00
9/24/93	18.00	
9/25/93	17.00	810,000.00
9/26/93	16.00	
9/27/93	18.00	870,000.00
9/28/93	19.00	
9/29/93	20.00	810,000.00
9/30/93	17.00	
10/1/93	19.00	430,000.00
10/2/93	17.00	
10/3/93	18.00	460,000.00
10/4/93	20.00	
10/5/93	19.00	560,000.00
10/6/93	18.00	
10/7/93	17.00	960,000.00
10/8/93	18.00	
10/9/93	19.00	890,000.00
10/10/93	20.00	

Water Consumption and Somatic Cell Count
on the Franze Farm

10/11/93	21.00	840,000.00
10/12/93	20.00	
10/13/93	19.00	730,000.00
10/14/93	18.00	
10/15/93	17.00	930,000.00
10/16/93	19.00	
10/17/93	20.00	840,000.00
10/18/93	21.00	
10/19/93	18.00	820,000.00
10/20/93	19.00	
10/21/93	17.00	740,000.00
10/22/93	19.00	
10/23/93	17.00	840,000.00
10/24/93	20.00	
10/25/93	18.00	820,000.00
10/26/93	19.00	
10/27/93	17.00	650,000.00
10/28/93	19.00	
10/29/93	16.00	680,000.00
10/30/93	18.00	
10/31/93	16.00	640,000.00
11/1/93	19.00	
11/2/93	18.00	520,000.00
11/3/93	17.00	
11/4/93	20.00	810,000.00
11/5/93	18.00	
11/6/93	19.00	630,000.00
11/7/93	18.00	
11/8/93	18.00	540,000.00
11/9/93	19.00	
11/10/93	20.00	650,000.00
11/11/93	21.00	
11/12/93	18.00	892,000.00
11/13/93	17.00	
11/14/93	19.00	910,000.00
11/15/93	20.00	
11/16/93	18.00	790,000.00
11/17/93	17.00	
11/18/93	18.00	650,000.00
11/19/93	16.00	
11/20/93	17.00	1,100,000.00
11/21/93	18.00	
11/22/93	16.00	790,000.00
11/23/93	19.00	
11/24/93	18.00	710,000.00
11/25/93	17.00	
11/26/93	16.00	650,000.00
11/27/93	17.00	
11/28/93	17.00	980,000.00
11/29/93	18.00	
11/30/93	16.00	690,000.00

Water Consumption and Somatic Cell Count
on the Franze Farm

12/1/93	17.00	
12/2/93	18.00	770,000.00
12/3/93	16.00	
12/4/93	19.00	890,000.00
12/5/93	18.00	
12/6/93	17.00	930,000.00
12/7/93	17.00	
12/8/93	18.00	900,000.00
12/9/93	16.00	
12/10/93	19.00	730,000.00
12/11/93	18.00	
12/12/93	16.00	980,000.00
12/13/93	16.00	
12/14/93	17.00	1,100,000.00
12/15/93	17.00	
12/16/93	16.00	1,200,000.00
12/17/93	18.00	
12/18/93	19.00	1,400,000.00
12/19/93	18.00	
12/20/93	16.00	1,800,000.00
12/21/93	15.00	
12/22/93	16.00	1,300,000.00
12/23/93	19.00	
12/24/93	16.00	1,400,000.00
12/25/93	20.00	
12/26/93	18.00	1,200,000.00
12/27/93	17.00	
12/28/93	16.00	1,000,000.00
12/29/93	18.00	
12/30/93	19.00	700,000.00
12/31/93	17.00	
1/1/94	19.00	740,000.00
1/2/94	18.00	370,000.00
1/3/94	18.00	
1/4/94	16.00	420,000.00
1/5/94	18.00	
1/6/94	17.00	810.00
1/7/94	17.00	
1/8/94	19.00	550,000.00
1/9/94	17.00	
1/10/94	18.00	460,000.00
1/11/94	16.00	
1/12/94	16.00	510,000.00
1/13/94	15.00	
1/14/94	16.00	560,000.00
1/15/94	15.00	
1/16/94	17.00	90,000.00
1/17/94	17.00	
1/18/94	16.00	680,000.00
1/19/94	17.00	

1/20/94	18.00	800,000.00
1/21/94	15.00	
1/22/94	16.00	790,000.00
1/23/94	17.00	
1/24/94	18.00	890,000.00
1/25/94	19.00	
1/26/94	18.00	670,000.00
1/27/94	16.00	
1/28/94	17.00	490,000.00
1/29/94	18.00	
1/30/94	17.00	450,000.00
1/31/94	16.00	
2/1/94	19.00	610,000.00
2/2/94	17.00	
2/3/94	18.00	610,000.00
2/4/94	16.00	
2/5/94	17.00	800,000.00
2/6/94	19.00	
2/7/94	16.00	610,000.00
2/8/94	18.00	
2/9/94	18.00	510,000.00
2/10/94	17.00	
2/11/94	16.00	690,000.00
2/12/94	19.00	
2/13/94	18.00	750,000.00
2/14/94	19.00	
2/15/94	17.00	540,000.00
2/16/94	17.00	
2/17/94	16.00	700,000.00
2/18/94	16.00	
2/19/94	17.00	810,000.00
2/20/94	19.00	
2/21/94	18.00	740,000.00
2/22/94	18.00	
2/23/94	19.00	640,000.00
2/24/94	23.00	
2/25/94	19.00	470,000.00
2/26/94	18.00	
2/27/94	19.00	440,000.00
2/28/94	20.00	
3/1/94	18.00	600,000.00
3/2/94	19.00	
3/3/94	18.00	500,000.00
3/4/94	19.00	
3/5/94	19.00	740,000.00
3/6/94	18.00	
3/7/94	17.00	690,000.00
3/8/94	17.00	
3/9/94	18.00	620,000.00
3/10/94	18.00	
3/11/94	18.00	550,000.00

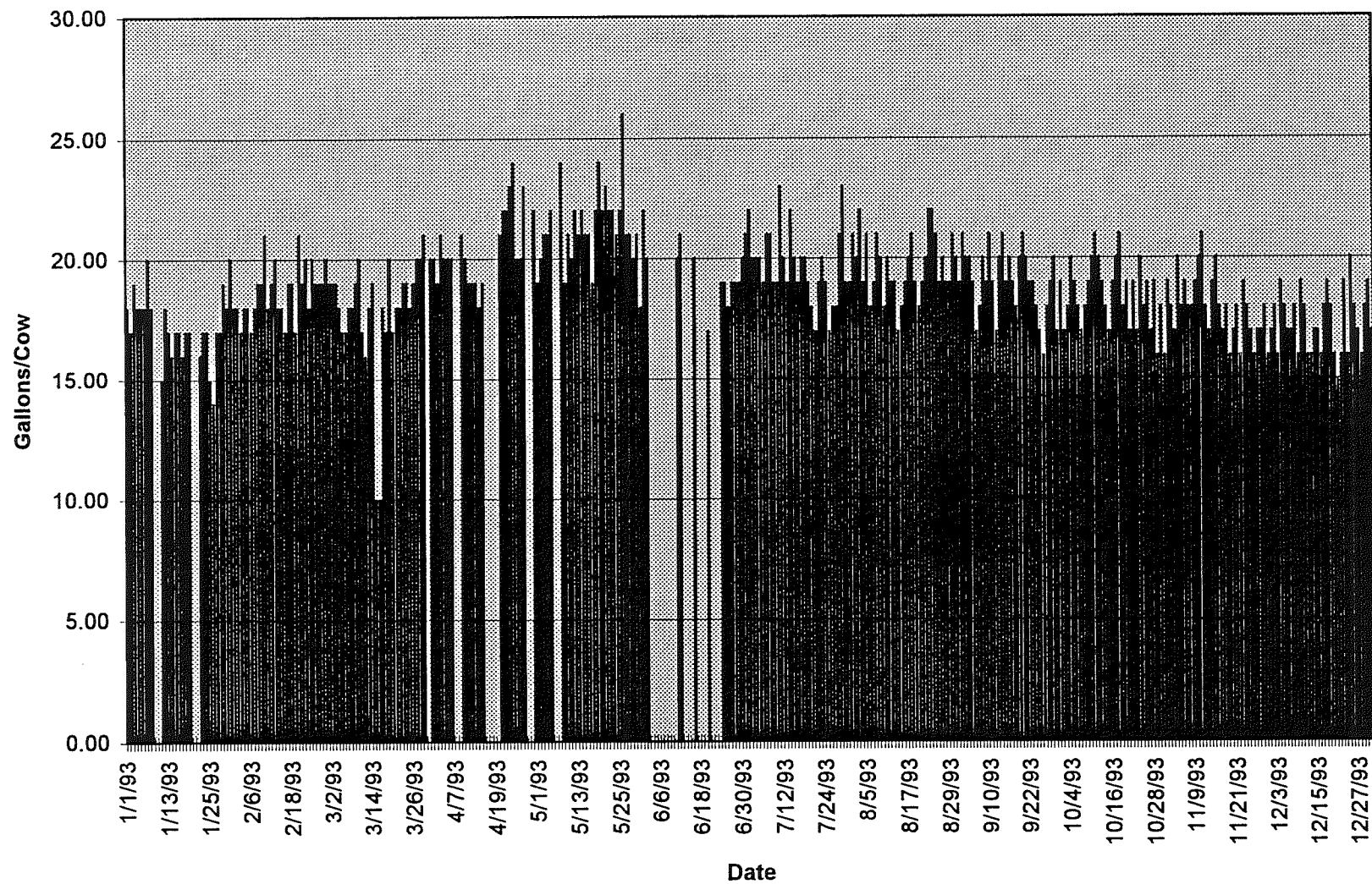
3/12/94	17.00	
3/13/94	18.00	
3/14/94	17.00	
3/15/94	17.00	61,000.00
3/16/94	18.00	
3/17/94	19.00	500,000.00
3/18/94	18.00	
3/19/94	18.00	900,000.00
3/20/94	19.00	
3/21/94	18.00	620,000.00
3/22/94	19.00	
3/23/94	18.00	700,000.00
3/24/94	18.00	
3/25/94	17.00	710,000.00
3/26/94	18.00	
3/27/94	19.00	820,000.00
3/28/94	18.00	
3/29/94	17.00	790,000.00
3/30/94	17.00	
3/31/94	18.00	680,000.00
4/1/94	19.00	
4/2/94	19.00	700,000.00
4/3/94	19.00	
4/4/94	18.00	720,000.00
4/5/94	19.00	
4/6/94	19.00	800,000.00
4/7/94	18.00	
4/8/94	19.00	680,000.00
4/9/94	21.00	
4/10/94	20.00	560,000.00
4/11/94	21.00	
4/12/94	21.00	590,000.00
4/13/94	20.00	
4/14/94	19.00	650,000.00
4/15/94	20.00	
4/16/94	19.00	490,000.00
4/17/94	19.00	
4/18/94	18.00	810,000.00
4/19/94	20.00	
4/20/94	17.00	780,000.00
4/21/94	19.00	
4/22/94	18.00	530,000.00
4/23/94	17.00	
4/24/94	24.00	820,000.00
4/25/94	22.00	
4/26/94	23.00	1,100,000.00
4/27/94	24.00	
4/28/94	25.00	850,000.00
4/29/94	24.00	
4/30/94	25.00	1,100,000.00
5/1/94	24.00	

Water Consumption and Somatic Cell Count
on the Franze Farm

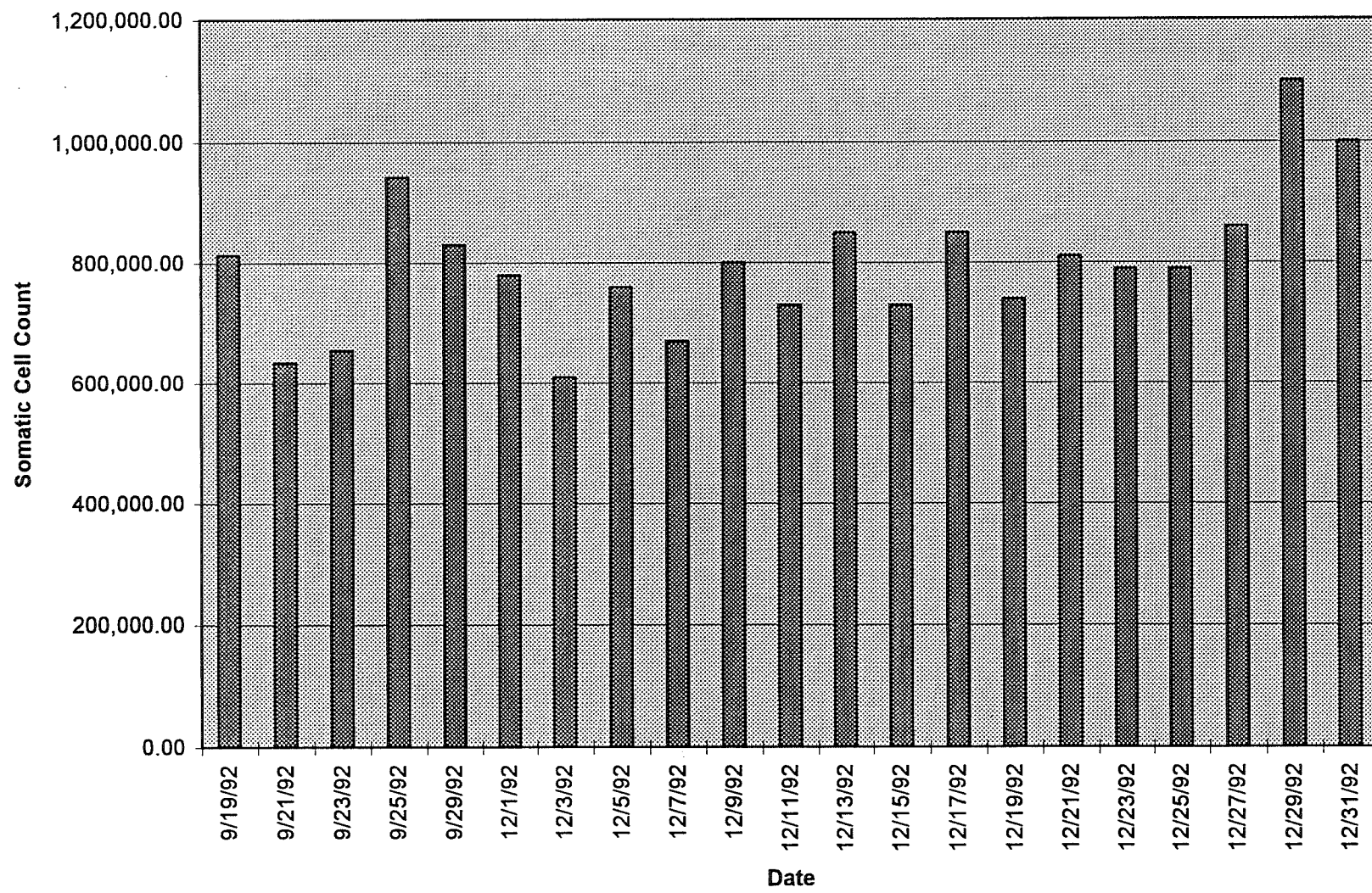
5/2/94	23.00	830,000.00
5/3/94	25.00	
5/4/94	18.00	1,000,000.00
5/5/94	23.00	
5/6/94	24.00	1,000,000.00
5/7/94	23.00	
5/8/94	22.00	860,000.00
5/9/94	23.00	
5/10/94	24.00	920,000.00
5/11/94	22.00	
5/12/94	23.00	980,000.00
5/13/94	22.00	
5/14/94	19.00	1,200,000.00
5/15/94	17.00	
5/16/94	23.00	1,100,000.00
5/17/94	24.00	
5/18/94	22.00	1,000,000.00
5/19/94	23.00	
5/20/94	24.00	860,000.00
5/21/94	22.00	
5/22/94	23.00	
5/23/94	18.00	
5/24/94	24.00	740,000.00
5/25/94	23.00	
5/26/94	25.00	740,000.00
5/27/94	23.00	
5/28/94	22.00	700,000.00
5/29/94	24.00	
5/30/94	22.00	760,000.00
5/31/94	23.00	

1993

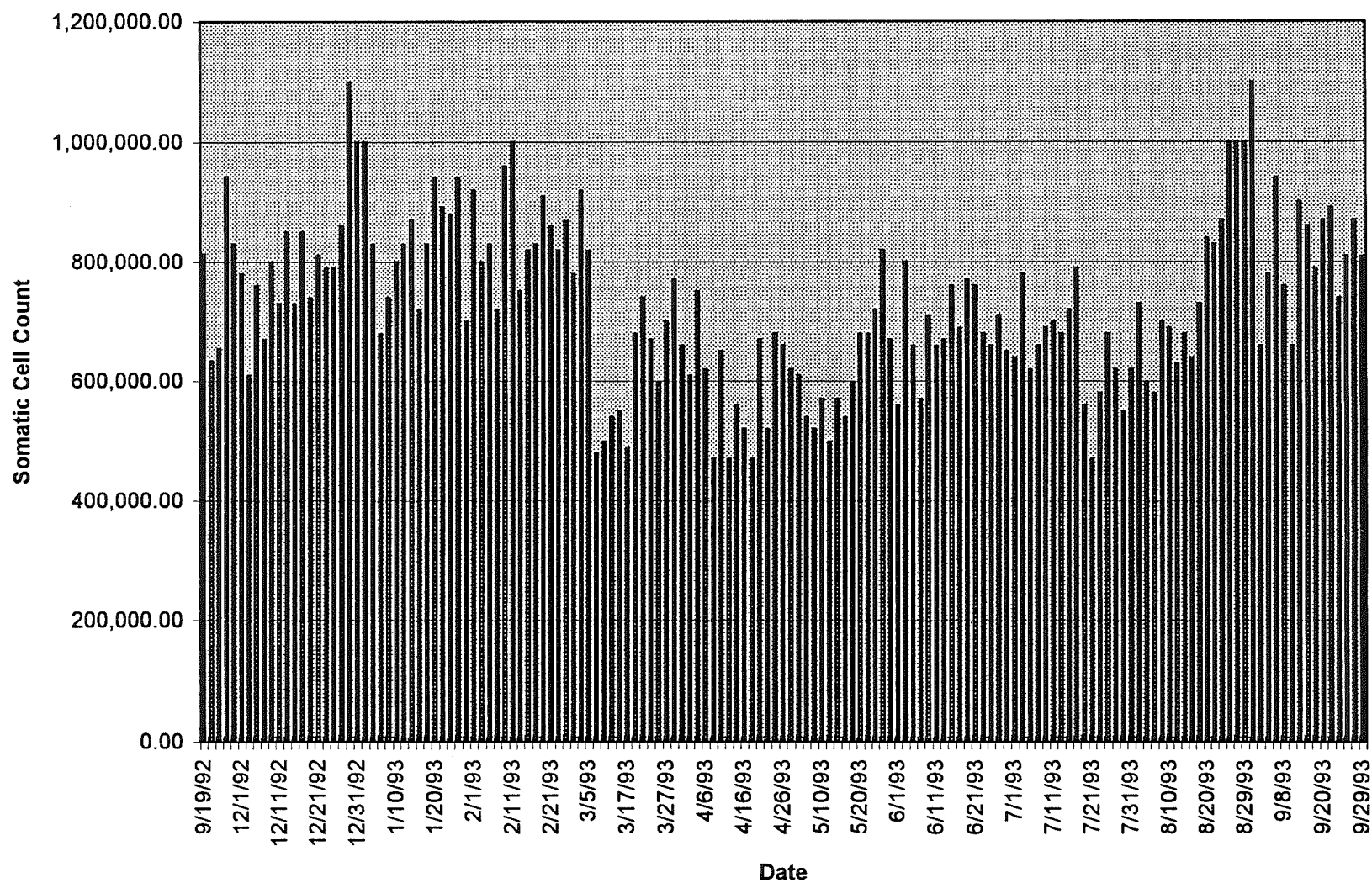
Water Consumption on the Franze Farm



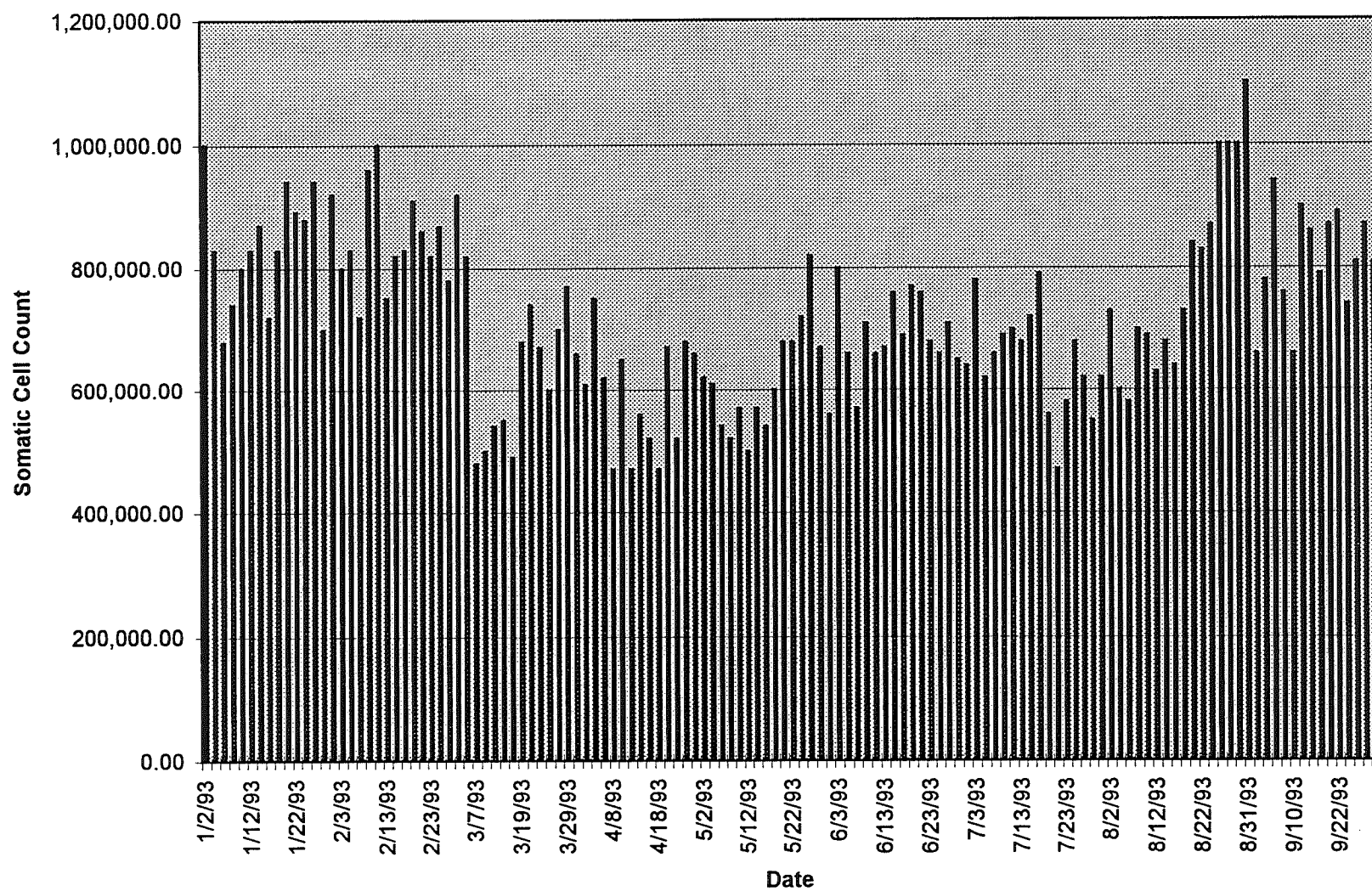
Somatic Cell Count on the Franze Farm



Somatic Cell Count on the Franze Farm



Somatic Cell Count on the Franze Farm



CASE 256
ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY
DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among un milked heifers)
Tanish discharge under eyes and nostrils
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die

HUMAN HEALTH

- 1st person tingling or numbness in arms or legs
- 1st person frequent headaches
- 1st person vision problems (e.g. blurred or heavy eyelids)
- 1st person problems with breathing
- 1st person excessive fatigue
- 1st person frequent irritability
- 1st person often feeling under stress
- 1st person weakness and pain in legs
- 1st person forgetfulness
- 1st person ears ringing
- 1st person pressure behind the eyes
- 1st person unexplained nausea
- 1st person unexplained general feeling of not being well
- 1st person rheumatoid arthritis
- 1st person (female) problems with menstrual cycle
- 1st person (female) had one miscarriage

ADDITIONAL INFORMATION

Symptoms observed for 32 months

This farmer is not farming now because stray voltage cost them too much money. In 2 1/2 years there was no way they could keep farming.

CASE 264

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production,
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among un milked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and bovine viral diarrhea (BVD)

CALVES

Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees, unable to suck, rolls tongue, diarrhea, and/or loose hair
Hard time raising healthy calves

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters

Cats leave farm and die

HUMAN HEALTH

2nd person frequent headaches
3rd person frequent flu-like or cold symptoms (asthma)
2nd person vision problems (e.g. blurred or heavy eyelids)
3rd person problems with breathing
1st and 3rd person excessive fatigue
2nd person frequent irritability
1st, 2nd, and 3rd person often feeling under stress
1st person weakness and pain in legs
1st person forgetfulness
2nd and 3rd person allergies
2nd and 3rd person pressure behind the eyes
2nd person unexplained general feeling of not being well
2nd person (female) feeling bloated/retaining body fluids
2nd person (female) problems with menstrual cycle
Sore knees
Painful bunions on feet
Toenails showing excessive growth

ADDITIONAL INFORMATION

Symptoms observed for 24-26 months
Most of the conditions have cleared up since they located the major source/transfer pump not grounded--four year ago. Cows and facilities still are not up to maximum production level, leaving them no choice but to get off farm work. Cows and people have still not totally recovered yet.
They are hoping this year's young stock will be healthy when entering the barn to get milked and stay around for a few years.

CASE 265

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Poor water consumption
Cows reluctant to enter barn and/or stalls
Cattle dancing back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or
cement curbs.

Production

Uneven, incomplete and/or slow milkout
Poor milk production
Breedback difficulties
Cow production peaking early and not holding
High somatic cell counts
Breeding problems, such as: silent heats, absorptions, and
spontaneous abortions

Health

Multiple or recurring mastitis (not responding to treatment)
Swollen legs and joints
High veterinarian bills
Leukemia/anemia
Inability to maintain weight in cold weather
Poor hair coat, constant lice problems
Inflamed sphincter valve (even among unmilked heifers)
Tanish discharge under eyes, nostrils, and ears
Stress rings on the hoofs (excessive growth)
Heifers and cows have trouble getting up (legs seem numb)
Tough hides which result in bent and broken injection needles
Immune system failures resulting in chlamydia, pneumonia, and
bovine viral diarrhea (BVD)
Excessive teeth found in feeders and feedbunk

CALVES

Calves having poor survival rate
Calves unable to grow at normal rate
Calves with symptoms such as abscesses, sore gums, burnt knees,
unable to suck, rolls tongue, diarrhea, and/or loose hair

PETS

Cats sickly with rough, dull and shaggy coats
Cats cease to bear litters or give birth to small, unhealthy litters
Cats leave farm and die

HUMAN HEALTH

1st and 2nd person tingling or numbness in arms or legs
2nd person frequent headaches
1st and 2nd person frequent flu-like or cold symptoms
1st and 2nd person vision problems (e.g. blurred or heavy eyelids)
1st person excessive fatigue
1st and 2nd person frequent irritability
1st and 2nd person often feeling under stress
1st and 2nd person weakness and pain in legs
1st and 2nd person forgetfulness
2nd person ears ringing
1st person pressure behind the eyes
1st and 2nd person unexplained nausea
1st and 2nd person unexplained general feeling of not being well
1st person having an illness that medical professionals cannot diagnose
2nd person occurrence of heart related ailments
Sore arms and itchy back

EQUIPMENT OR MACHINERY PROBLEMS

Noted were:

incandescent lamp failures (sometimes in groups, explosions)
increasing motor burnouts
occasional shocks from water lines or faucets
noisy telephone requiring frequent service calls or having false rings
accelerated corrosion of well casings or other buried pipes
unexplained fluctuations in electric bills

ADDITIONAL INFORMATION

Symptoms observed for years
Family members treated frequently for heart, nerves, aching legs, and tumors.

CASE 266

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cattle were very nervous

Cattle were difficult to lead into the barn

MEASUREMENTS

Between cow stations and ground is 3 volts

ELECTRICAL PROBLEMS ON THE FARM

The electronics of the milker was feeding small amounts of current to ground. This change resulted in 90% less mastitis, cows became a whole lot less nervous and less trouble getting into the barn and the stalls. No change with the dairy herd was observed after these electrical changes.

ELECTRICAL CHANGES AND CORRELATING EFFECTS

The electrical wiring changes made on the farm are as follows: aluminum to copper wires were looped and tightened and ground connection on farm grounding rods was renewed. There are no electrical transmission lines that have recently been added and no natural gas or oil pipeline near the farm.

Cows became a whole lot less nervous and less trouble getting cows into the barn and stalls.

OBSERVATIONS

Last time the farmer had stray voltage (the third time) the electrician had all new testing equipment and could not pick up anything. Yet he held his hand near the bulk tank and one could see and hear the sparks jump. It was very similar to static electricity.

CASE 269

ANIMAL AND HUMAN SELL BEING AS DOCUMENTED BY DAIRY OPERATOR

CATTLE

Behavior

Cattle kick milkers off

Production

Breeding problems such as silent heats

Health

Leg problems

HUMAN HEALTH

Unusually tired

Frequent cold symptoms

HISTORICAL INFORMATION

There was an electrical transmission line added 10 years ago.

In Jan. 1983 they noticed a big difference in the production B.F and protein. They all dropped a lot. In the fall of 1984 the heifers started falling apart, some went down and had to be destroyed. They still have some leg problems. (mostly in the heifers) In the human health they seem to be more tired than they used to be and seem to get colds more easily.

The cattle behavior seems to vary a lot. One milking they kick off units and the next they stand still. No heats for weeks then, they will start to come in heat. Dry weather seems to make the most difference, wet weather seems to be worse, sometimes weekends are worse.

MEASUREMENTS

We used a swain meter on ground wires and anchor wires. We found 30 to 35 milli amps. They disconnected the main and still had readings in cow conduct points.

MITIGATION

The tingle voltage filter was installed in 1983, but did not do anything. The EGS was installed in 1986, but that came up some, but otherwise not much change. The neutral isolator was installed in 1991, it made the most difference over production. It has increased steadily since they do not have the ups and downs as they used too.

Case 274

ANIMAL AND HUMAN WELL BEING AS OBSERVED AND DOCUMENTED BY
DAIRY OPERATOR

CATTLE

Behavior

Cows extremely agitated

Production

Cows heat cycle would stop or come in early

Health

Eating 20-30% more than required for production, no corresponding weight gain

Dysentery

Sores and abscesses that do not heal

Cows would dehydrate and go into shock (no apparent reason)

Fluid retention

Organ dysfunction

Blood in urine, no medical symptoms

CALVES

Require 25% more milk replacer, otherwise death rate of 50%

Autopsy revealed no fat on organs (yet, no signs of malnutrition)

PETS

Cats extremely small

Cats would sicken and die within 24-48 hours

Unable to keep cats alive for one year

Goat was extremely agitated and difficult

HUMAN HEALTH

Sores on body would not heal
Difficulties sleeping (1st person sleep apnea)
Irritability
Dizziness
1st person reading and comprehension slowed
Loss of bowel control while in electrical field
Muscles spasms and cramps
Diarrhea (fluid and undigested food)
Female menstrual cycle erratic and signs of menopause (cycle returned to normal once off the farm)
Mental instability
Fluid retention followed by immediate need to urinate (if did not urinate immediately, either could not urinate or empty bladder - diarrhea would start)
2nd person heart arrhythmia (no physical cause evident during physical)
Nausea
Numbness in arms and legs
Blurred vision
Night sweats and grinding of teeth while sleeping
1st person unusual urinary tract infection
Children suffered from skin condition, "fish scales," while on farm
Organ dysfunction

GENERAL INFORMATION

FARM CHARACTERISTICS

Satellite picture showed and electromagnetic field 275 feet wide, with positive and negative side, believed to be man made.

Natural Gas Dome and Natural Gas in area affecting farm and electrical field, according to Satellite engineers.

ELECTRICAL EFFECTS ON THE FARM

Noted were:

shocks from wet grass, metal ladders
dysfunction of pacemaker
radio frequency lost

HISTORICAL BACKGROUND

Family has suffered from numerous health problems while on the farm. Problems have consistently improved when away from the farm. These effects have also been evident on visitors to the farm.

CASE 501

WRITTEN BY A DAIRY FARMER AND TRANSCRIBED AS AN EXAMPLE OF THE PROCESS UNDERTAKEN BY DAIRY FARMERS EXPERIENCING STRAY VOLTAGE

Names have been changed.

In October 1980, we began milking cows. The first two years were somewhat uneventful. There were a few problems, and our herd consisted mostly of heifers. Some hurt their knees, and were unable to get up. We also had a couple breech births, and the usual problems encountered when dealing with animals. However, the fall and winter of 1982 was a different story. Problems began and seemed to take all our time. Cows that had milked in 3-4 minutes were now taking 7-8 minutes, if not more. Milking became a difficult chore. Also at around this same time, the vet was at our place frequently. It seemed like every cow or heifer that freshened had either ketosis or milk fever. We had many problems including twisted stomach, allergic reactions, abortions and still born calves. We also had healthy calves with no visible symptoms die over night. The biggest problem though was mastitis. It's hard to evaluate it all due to the fact we had to ship and replace cows continuously in order to pay the bills. At any one time, the most treatable cows that we had milking was 25. A total of 30 cows were treated. 56 individual quarters were treated, with a grand total of 576 single doses of mastitis treatment. You can see that this cost us not only in terms of medicine, but also in terms of loss in milk production.

Three cows were also treated by the vet because they had both mastitis and high temperatures. The last one treated was a beautiful heifer. 3 milkings after she freshened, she developed a fever. We called the vet who treated her with IV antibiotics and udder infusions. We also gave her forty c.c.'s of antibiotics daily. Twenty c.c.'s morning and night, plus udder infusions of mastitis treatment. This went on for five days. She was seen twice more by the vet, yet nothing worked. On the sixth day she died.

Also during this time we had five cows abort their calves all during the seventh month. There was also another incidence of twisted stomach and two cases of pneumonia. Our cows wouldn't settle and we ended up breeding many of them over and over.

We came up with many explanations. We weren't milking them right. It was the vitamins - we shouldn't put them in the feed. It had to be the silage because the cows wouldn't eat it. We'd cut down to feeding silage only once a day, yet even then what was fed in the morning was thrown up at night. These cows had the best of everything in their feed, yet when you fed them, they'd look at you as if to say "You really expect me to eat that?"

I could just cry (and have many times) just thinking about how those poor animals were tortured. Here they were, in our care, tied by the neck, and daily receiving doses of electricity 8 times greater than the level known to cause cows stress. I wish they could have told us what was wrong.

It took time and effort to find the problem. The field-man for our milking machine came out and taught us new milking techniques. Still no change. We changed the vacuum, the inflators and the feed. We talked to other milking machine dealers, who said that it was the milking machine. We'd do better if we switched to theirs. So, we got estimates on new milkers.

Land O Lakes has been very helpful. They ran tests on the milk from all the quarters and called with the results. In a herd of 21 cows - by now some cows had just quit milking - we were treating nine cows at a time for mastitis. We had milk everywhere. I got so sick of seeing those ice cream pails that had to be washed every morning and night. The baby calves and yearling both received whole milk. Most loved it, but we did find that some cows wouldn't even drink it. We were certainly doing our part in holding down the milk surplus.

Finally one night while talking with friends, we got a "hunch". They were telling us about their problems. Their cows would freshen , only to dry up in a few months. They had also had numerous cases of mastitis. Stray voltage had been their problem! They had been informed of that when a field-man for Land O Lakes had brought out a meter for them to use. So I called John our field-man. He had been as puzzled as us, and brought the meter out the next day. We found that our bacteria count was still excellent, but that our somatic cell count - which was earning us a bonus for "quality milk" had been climbing for a long time.

Pete and I began checking with the meter as soon as he got home from work. (Pete had hoped to retire from the siding business when we started milking, but with things the way they were, there had been no chance of that. His siding income was paying the bills.) The meter read 3.96 volts. When John came the next day to pick up the meter, we told him our findings and he double checked them. We had read it right. Something was very definitely wrong. The men began investigating. First they cut off the electricity at the main box outside - still 3.96 volts. Next they loosened the ground wire in the main boss and the sparks flew! The meter read 11 volts! I called the power company. The company was either in no hurry or their equipment was busy. We waited for what seemed a very long nine day, before they brought out testing equipment. During this time, we had our local electrician come out and check. He too found the voltage, but he could not do anything about it since it did not originate on our farm.

Finally the big day came and along with it trucks with men from the power company. They didn't believe that we could have a problem because we were in the middle of the line, not at the end of the line where stray voltage usually occurs. Well, they did this and that, and finally put a little white padlocked box in our utility room. I was very curious to see the results.

The following day was Thanksgiving, and we were busy with a house full of company. For a while, we actually forgot the stray voltage or "juice" as we'd come to call it. The day after Thanksgiving, in rolled the trucks and off came the padlock. Yes! They were certain. We did have stray voltage! The trucks rolled again, this time to shut off our neighbors electricity, since the meter had proved the "juice" was not coming from our farm. They found the source of our "juice" at the second stop. A 120 volt line, was laying on the ground. Its covering had decayed, leaving electricity to short into the ground. After traveling the 1/4 mile across the field to our barn, the men cut the line. Levels dropped from the previous 3.96 to .02.

Well, that was a great relieve to both us and some of our cows. The gutter has water in it! Lots of water! I couldn't remember when those water cups had been so busy. I guess they had been, but that was back when I was a visitor in the barn and our son Brian milked with his dad.

There was a noticeable change in some cows immediately. For others it will take longer for the experts to tell us. The cows do like their silage now though, and are even licking it up off the floor. Spice, a cow who previously had bloodshot eyes and a depressed look about her, now lays and chews her cud very contentedly. Penny, who would previously kick, jump and fight the stantion, is now back to her peaceful self. I suppose it was her way of fighting back! The remaining cows are no longer suffering, but a lot of quarters have been ruined from having mastitis so many times. Halo, the sweetest littlest heifer of all, will probably have to be shipped. She only has one quarter left that milks anywhere near normal capacity.

When you have to pay the banker, you can't afford to be sentimental.

Back in 1973, when we moved here, this place was 80 acres, with a hundred year old house. Since then, we've bought another 80 acres, built a new home, barn, silo, machine shed, granary, hayshed, and beef barn. Between farming and the siding business, there are no vacations or days off. We've done our best, and if things had continued as they were, we might have lost it all.

I get so angry when I think of the troubles and suffering, human as well as animal. High hopes that never came about. Not due to poor care of our animals, but by something unseen, that came in the very ground we live on.

I hope by writing this, maybe someone else will read it and it will give them that "hunch". Maybe they won't have to ship Sally, Lilly, Pet, Shadow, Daisy, June, Comet, Bossie, Pepper, Shiny, Vivian, Dale, Punkin, and Big Ol Bessie, or watch their Holly die. Of NO KNOWN REASON, or so the autopsy said. Poor Jumbo, who died from a cement burn on her leg that only got worse and wouldn't heal up. Black Beauty, a heifer who died from mastitis that wouldn't respond to treatment.

We learned a sad, hard, and expensive lesson. If you're having an unusual amount of trouble, have an electrician check for stray voltage. It may save your herd and your farm.

* * * *

It's now June 25, 7 months since we found that we have "stray voltage" here. Two more cows were given up on and shipped. Trouble is still with us.

I wish I could enjoy milking those cows like I once did. I wonder how a person can feel so many different emotions all at the same time. My heart is heavy tonight; we've decided that farming and the siding business together are more than we care to handle. The current phrase, "burn out", certainly fits. That's exactly what is happening to us. Ten years of 6:30 a.m. until 9:00 p.m. days, with no vacation, have left us feeling (pardon the language) like saying "To hell with it!"

Saddles had to be treated again for mastitis tonight. I've lost count of how many times that makes for her. Call it a fight to keep her, or call it stupidity. Every time we treat her, we say "This is the last time." Last week it was Exon and Spottie. Spottie freshened with ketosis and mastitis, like we expected. The poor cows would shudder sometimes if they could read our minds. Sometimes you get so angry you'd like to ship them all. Then you remember that it's not their fault. They try. Even when they were being shocked, most of them were still gentle.

Yet what can we do? Treat them again? Every time you treat a cow for mastitis it costs \$30 - \$40. We are going broke shipping them for \$325 and buying replacements for \$800. It's especially hard to ship them when you've finally gotten them bred back after trying over and over again.

What if we have an auction? Do we tell the prospective buyers "Hey! These girls have been subjected to stray voltage. They've been treated ump-teen times for mastitis and probably won't be worth a damn!"? Fat chance anybody would want them. We keep hoping they'll be okay, but then we're optimists.

Exon, Spottie, Saddles, Dottie, Sno-bird, Velvet, Lucy, Halo, and Horny are all in the same shape - ruined as far as being a healthy milk cow. We've even found our heifers that were outside were effected. 8 out of 10 freshened with mastitis. They weren't tied to the "juice" like the cows inside the barn though, so maybe they won't be totally ruined. Daisy, Candy, Gypsy, Whitie, and Lady each have one light quarter. One thing interesting about stray voltage damage is that the cows all follow the same pattern. Mastitis, mastitis, and more mastitis. You'd think by now we'd have learned. They just don't get over it. But we keep on treating them and hoping for the best. What else can you do?

Pete's out cutting hay now. He's been siding all day, and then came home to cut hay until dark. Sometimes I wonder what keeps him going. Actually, it's no secret - the loan's coming due soon.

Some days I sure hate the thought of selling this place. We've worked so hard to make it what it is today. Other days I can't wait to get out! It's a trying time. We're torn between two worlds. We know without a doubt that when and if we find a buyer, someday we will regret selling.

The last straw for us has been all the problems and expenses connected with this stray voltage problem. It's constantly on our minds. Every time we see a cow's deformed bag. An empty stantion that shouldn't be empty. Velvet and the others that dried up early because they couldn't stand the stress. Saddles not milking because she's got mastitis again. It all just makes you want to scream! How unfair it all is. Especially when you find out that the people whose farm caused all this - over 2 years of fighting illness and frustration - have liability insurance. They are also being hostile about it. THEY are being hostile. Why? WE are the ones who have the right to be hostile and more! The only way we can get any satisfaction is to take these people, our neighbors, to court! Now gossip has US as the bad guys. Isn't that a kick in the pants!?

People don't realize that our neighbors aren't really being sued. It won't cost them a single penny; their insurance company would pay for our damage. We can't understand why we must continue to suffer in order to get justice in this matter. Isn't it enough that a long period of time life was difficult here? Our future is being destroyed by something out of our control. The remaining cattle we have left are still ill from the side effects of that stray voltage. We are still having problems with the remaining cows who lived through this period of torment. Now to mention our own personal stress and anguish caused by this situation. It is beyond our comprehension that we can prove these fact, but still have to spend time, money and energy to get what should be indisputably ours.

But, I guess that's how the system works. You have to prove you neighbor negligent. Then and only then will you be compensated. It's not right when you're already the victim.

* * * *

Aug. 18, 1984

It's fun time again at the Jacksons. Land O Lakes called with the results of our s.c.c. test on the bulk tank sample. It was really great. Only 2,600,000 - illegal milk. The man said, "Clean up that herd!", so we got out the old c.m.t. equipment again. That makes the third gallon of that purple stuff that we've used up testing these cows. That much would last a lifetime in most herds our size. We tested every cow - to keep our count good. Out of 32 cows now milking, we've had to ship all but 9. The neighbor's juice strikes again. Or should I say stays on and on and on. I guess everyone I talked to was right. Everyone who had come into contact with stray voltage told me the same thing: "Ship 'em - they'll never come out of it. We've done everything possible and still the mastitis lingers. Bag infusions by the gallons it seems. Muscle injections of antibiotics. Mastitis vaccine three times what is usual. But the germ is still there - hidden somewhere in those poor scarred up bags. God help me, but I HATE our neighbors and I wish them all the ills that they've caused us.

Tomorrow we ship cows: Lucky - 2 teater with mastitis; Candy - 3 teater with mastitis; Daisy #2 - 2 teater with mastitis; Dottie - mastitis in all 4 quarters, treated 8 times with no results; Dolly - bad mastitis in all 4 quarters, treated six times that I can recall; Blackie - 2 teater with mastitis. Snow Bird should go too so she can be put out of her misery. Her bag is humungous - we could never get her cleaned up after the mastitis. We can't ship her for 3 weeks due to the injection of antibiotics.

Land O Lakes is running s.c.c. counts on the remaining 14 animals. Ship or treat? Another decision to make.

Sept. 24, 1984

Well, the counts are back. Of the 16 counts done, 7 cows are over 2,000,000, 4 cows are over 1,000,000 and the rest are okay. So we treat again. It's hard to give up and ship them because we're fighters! And they are our friends. Shipping them is like admitting we've lost the battle. We've lost too many not to go all the way with these. 10 cc's of penicillin - twice a day. 15 cc's mastitis vaccine. Double tubes of udder

infusions per quarter - twice a day for three day. We'll retest after a week to see if we've gained anything besides a depleted checkbook balance.

Nov. 3, 1984

Saddles and Exon finally calved. Although, it was better not to know and to just wonder how they'd be. I'll tell you, this mastitis-causing germ is tough. We've treated those two cows for 2 weeks, and they freshened with mastitis. Saddles in 2 quarters, Exon in 3. It was so bad that for three days they milked water with lumps that looked like cottage cheese. Then it started to at least look like milk. We goofed again. We should have shipped them before they calved. High hopes once again bite the dust. So we're treating them again. We had the vet out to look at Exon. We're using the same treatment on Saddles. Once again we're caught in that same trap - we can't ship them because they're on antibiotics. That means we have to keep them for 20 days. At this point we're spending \$100 per cow on treatment. Since we're that far already, we might as well treat them until their milk is sellable. That adds on another \$100 per cow. If we're lucky we'll get out of this mastitis well enough that we can sell the milk.

We'll probably never see that quality milk bonus again as long as we're forced to keep cows like these. Here we have two cows with the potential of being 70 - 80 pound cows reduced to something that makes me sick. I really hate selling what I think is sub-standard milk, but Frank says I'm crazy. On grade B we'd be above excellent, but I don't care. We're grade A and I want grade A milk.

God in heaven, I've never had such stress as the last two years. You get so depressed it's unbelievable. It sure helps to get it out on paper. Gets rid of some of the repressed anger. This whole family has suffered because of Perala's stupidity. Pete and I argue over cows. I say ship, and he says we can't afford to. He keeps telling me that we have to hope they'll be okay. I ask him when they've ever been okay. He does have a point though. We have gotten the herd up to the point where we can sell the milk. But that's not my standard of milk.

The kids get uptight because we're uptight. We're depressed. We're always tired. We've been at war now for over two years! It tires you out. You have no patience. You only ask to be left alone to sleep. We've used so much physical and mental energy on those cows that we have none left for our family. We're always wondering if there isn't something more we can do.

We did find a new product - something called Zinpro. It's meant to help somatic cell counts. So, we'll be using that now. Plus extra vitamins, minerals, and etc. We're hoping to keep them in the best possible health so that their own bodies can fight back as much as possible. I suppose it must be working, or we wouldn't have been able to save as many as we did.

It's really sad. You look at them and see beautiful cows - sleek and shiny and the picture of health. All except the most important parts - their udders. They are a mess. They feel tortured. It feels like a mass of hard ropes all twisted and knotted. I really hope it's not as painful as it seems to be.

Nov. 10, 1984

We found out we're not out of the woods even with our heifers! They've calved with mastitis. We've treated them all, ump-teen times, finally got them bred, dried them up, treated them for mastitis, vaccinated them for mastitis, and then used dry cow treatment. 3 weeks into their dry period, we noticed swollen quarters. Now it seem that we have to treat them even when they're dry. Kelly and Freckles both had "dry cow mastitis". Gypsy - a new one - she has straight blood in all four quarters! Another visit from the vet. He says "strip them out, and treat it like you do mastitis any other time." So we did, and

will continue for a couple of weeks, or until she freshens on Nov. 21. Hope we can get her healed up by then. We've already gone the distance with her. Beautiful large cow. We had to breed her 14 times before she finally settled!

We're sure going broke fast.

We paid the vet \$200 when he came out to treat Exon and Saddles. Then he had to come back again which cost \$500. We're always falling behind on the vet bills. Doesn't help much that we're still throwing away the milk from Exon, Saddles, and Sunny. They are all being treated. Pete milks Kelly and Freckles and Gypsy with the surge, so it really keeps me hoping with the other three milkers. One is all he can handle when they need special treatment, stripping and medicine. Boy, the consumer doesn't realize what all goes into the milk they buy. If they did, they sure wouldn't complain about the price they pay for it.

Today is deer hunting. Last year at this time we didn't know we had stray voltage yet. I sure can see a difference. Last year, the barn was 80' long and we had 24 cows at the most. I remember having to clean up 8 heaping wheelbarrows of feed and silage that was given and not eaten. Hard work, and such a waste! This year there was none. They eat it all now.

So while we waited, we had a stray voltage expert come out. That was probably the smartest thing we've ever done. He took one walk through the barn and said that the voltage was coming through the water line. He said it was grounded to the electric utility and that we should cut out a piece of that metal water pipe and put in plastic pipe. That will keep the voltage out of the barn water line. Marvelous! Such a simple thing. Why didn't anyone else tell us this? All they could talk about was a \$1000 isolating transformer and something about cows possibly being killed by lightening. A \$.50 piece of plastic pipe and 15 minutes of time cut the voltage at the water pipes from over 1.5 volts to .02 volts. Think of the suffering we've had and now we find a piece of plastic pipe would have made it all disappear. He also said we could change our trainer. The one we were using was not u.l. approved. We had assumed when we bought it that it was safe, but he disagreed, so we bought another.

Three days without stray voltage in their stalls and water cups, and it's like milking a different herd! Velvet showed up with mastitis which was a first. We treated her in the morning, and she milked out completely soft and normal. Now that has got to be a first! We're used to treating at least 4 milking and then maybe the quarter will soften up a little.

I wonder how we'd feel about farming and milking if we hadn't had all this trouble. I bet we wouldn't be praying that someone would come along and buy this place so we can escape before we're all completely crazy. What's the reasoning for all this? I've always believed that everything has a reason and is all well in the end. Well, I sure hope this all ends soon.

Now I'm furious. The utility came and rechecked our voltage and electric system after cutting our neighbor's wire about exactly a year ago. Did they find at that time that we were picking up stray voltage in the barn through the grounding system? We're 3 days without voltage and I believe there's been a tremendous improvement in the herd. So, in other words, this whole year's problems could have been avoided if they would have told us that we were still getting some stray voltage in the barns. Couldn't they have told us that they could've done something about it? They KNEW how susceptible our cows were to even the smallest amounts of stray voltage! Especially after all those cows went through. No one said anything, so we spent another round of fighting and losing more. Maybe those 7 cows we shipped didn't have carry over from our neighbor's voltage but new stress from the utility. Or what about all the mastitis last year and the 2 twisted stomachs. The poor cows lying on the floor, constantly irritated by that electrical current. The utility has the tape from last year's test. We're going to get a copy of it. If we find out that they knew of this problem at peak hours, they will be at the wrong end of a law suit. That would be "full neglect" on their part. Is the whole world against us?

Dec. 18, 1984

Where to begin. Relief is here. On Dec. 11, 1984, the utility installed a marvelous thing called a "blocker". Pessimist that I've become, I keep checking the volt meter. .05, .04. I can't believe it quite yet. So I keep checking. It's finally beginning to think in the cows are safe at last! It's almost a let down the feeling that I have. It's a big change after being on edge for so long, uptight day and nigh, feeling for the cattle without being able to help them in their torment. Now it's over!

I can rest. Heck, I've actually slept 4 night in a row without anguishing before going to sleep about what's going on out in the barn. I haven't woke up in a sweat for 4 nights. I used to dream of going in the barn and seeing all the calves and cows stretched out with their eyes rolled back in their heads - most of them dead. I kept trying to get Saddles up to get her out of the barn, with no luck. I can't lift her and she can't get up. I'm crying and screaming and then I wake up. I've had that dream so many times I've lost count. When I wake up I feel so terrible. Almost like the devil had taken my feeling over and I want to make someone pay for all this trouble and torture. It doesn't help to realize that it wasn't done on purpose. It doesn't help those animals that died or suffered for so long. It doesn't make my nerves any better. I suppose time is all that will help

Poor Lucy. I guess she was uptight waiting for the juice to begin again. She showed lumps again. Mastitis. There's a difference though. We treated as we have many times before, but this time we only had to treat her twice. Morning and night, and the milked out soft and normal. I can't get over the change! Never before have they reacted this way to treatment for mastitis. There was never any noticeable change after the treatment, no matter what we used and we used it all! A lot of the cows' bags are noticeably different now since the blocker has been installed. Mars and Jan never would milk completely out in the back quarters no matter how you'd talk to them or massage their bags. Now they milk out with all quarters soft and deflated looking. What a difference. In November, our D.H.I.A. s.c.c. count showed a rise in every cow except 2 who stayed the same. I bet we see an improvement in the breeding program now as well. Trixie was a first time heifer so she was bred outside the first time, where it was safer from the stray voltage. I am really anxious to test again. I can hardly wait. I'll bet my left arm that we will see a big improvement in that somatic cell count and a rise in production. I just know it! Premium milk again. Won't that be great! Heck, I'll even bring in proudly into the house for my family to drink - something I haven't been able to do for a long time. We've had okay milk I guess. It wouldn't make you sick or anything, but with the somatic cell count so high, I feel like my family deserves better. So with all the milk we have here, and our own pasteurizer, we still buy milk. That gets costly when you go through 6-8 gallons a week.

The attorney is going to add the electric utility onto the law suit. It leaves us with mixed emotions - the utility, being a co-op. It's almost like suing yourself. Being as they say - the co-ops belongs to us all. Heck, we even have our doubts about the thing with our neighbors. We'd feel better if the legal paper said we were suing the insurance company and not our neighbors since we want them to pay the damage, not the neighbors. Heck, that's why our neighbors carry insurance. Some days, in fact most days, we feel like saying to heck with the whole suit. But then comes another bill we can't pay. Boy things around here sure would have been different. We'd have had extra cattle. We wouldn't have to buy all those replacements, or borrow money to do it. Thousands of dollars lost due to mastitis and medicines that might as well have been waters. All the vet bills, extra breeding charges and costs. We might have been able to have a nice Christmas without charging all the gifts. We haven't had cash for a long time. We're lucky if we can keep up with the feed mill so they won't put us on a cash only basis. I wonder and Sears and Wards will even let us charge those things I called in. No Christmas here if they don't. Pete has to go see the banker again and try to borrow another \$5000 just to keep us through December. We owe them over \$50,000. It shouldn't be! We could have made it if stray voltage hadn't disrupted and interrupted. Our farm and lives were raped by that unseen devil.

Oh yes. We had the vet out again for Lee - the cow that developed sores on her hock. He told us to shoot her because she'll never be able to get up. I think that makes number 31 we've lost to stray voltage. Then

add Trixie and Exon who might come out of it yet. The one freshened with water in all quarters. The mastitis was so bad that what she milked wasn't milk. It looked more like cottage cheese. Then, finally it at least looked like milk. No different than the other cows - not something you'd be proud of - buy something that the milk company will accept. Her count is probably into the millions. After the blocker was installed, we treated her again. Probably the 12th time. We gave all the cows 2 more shots of mastitis vaccine. Poor things. They've gotten vaccinated and treated so many times their old butts must be like a sieve. They don't even flinch any more. They just stand there to be zapped with the old needle again. Gentle creature. If someone had tortured me with electricity for months on end and had given me shots all the time I'd kick off their heads. Yet they still love us, lick us, and never hurt us. Quite amazing. Pete's given hundreds of shots - maybe even thousands - these last four years. At first he just hated to give shots, but now it's such a common thing around here I don't even think it bothers him. It has to be done. I'm glad he can do it because I don't think I could.

My son shot Lee. It bothered him to do it, but we all hated to see Lee lying out there not able to get up, having to lift her by the hip bones hurt her. They had to do it though to get her out of the way of the barn cleaner. We've had to many things that seem cruel to me. But I guess when there is stray voltage ruining their health, you aren't in charge any more. Nothing works right. My son shouldn't have to shoot a cow that trusted him! I think he did it to spare Frank. The trusting cow never knew what happened. What a shame that such a beautiful animal had to be tortured here and die here without a chance. Stray voltage certainly must be the devil's tool

Jan. 15, 1985

Yesterday was the big day. It was actually sort of a let down. The insurance experts, the lawyer, Jeff, the stray voltage experts, and the electric company were all supposed to come out. They were going to turn the wire back at our neighbors, take our blocker off, and prove to the insurance company that our stray voltage, without a doubt, came from our neighbors. Came into our buildings and lives and caused all this misery. We worried for another week, wondering what effect turning the current back on would do the cows. It turns out that the electric utility and the insurance company wouldn't follow through. They didn't want to take the chance that the stray voltage would hurt our neighbor's cows!!! So the men did testing at our neighbors and here. If any good came out of the day, we've yet to hear about it. It sure messed up the milking routine though. We were out here really early. We wanted to make sure we were done milking and the cows had plenty of time to finish eating before their home got "hot" again.

Jeff seems to think that some good came of the day. Pete says that Jeff looked as if he wanted me to shut up, but I didn't notice. I hope I didn't say the wrong thing. The insurance company asked the questions. I answered them the best I could with the truth as I know it. I'm not going to tell stories or try to change any facts. Once you tell a lie it just leads to more and pretty soon you can't remember who you told what to. Let the chips fall where they may - I still believe good and right win in the end. I'm just happy that things are back to normal here again. Our barn is a place of peace again. Just being there listening to those gentle animals has a calming effect on me. I really enjoy milking cows. I wonder at their gentleness. They have such beautiful, kind, big brown eyes. I wonder what they think when they look at us.

Frank thinks I'm crazy, but if we sell this place I want to keep this year's heifers and build a new barn and milk cows. It will be like keeping all these "girls" with me by having their daughters. The only difference will be no field work. I intend on buying all the feed and hay. I won't keep their calves because I intend on breeding them with an angus bull. That's not so hard on them. It would also be nice to get chores done in less than an hour instead of two and a half. It would be a good income for an uneducated person like me. Besides - I'd go bananas just doing housework. I am too darn old at 44 to start college. If I did anything, I'd like to go into research. Natural foods and vitamins to cure the ills of mankind. Or I'd like to be a doctor. Far fetched ideas for someone 44 years old! Better to be happy milking cows.

Feb. 8, 1985

All seems to be going well and normal at the Jacksons. The cows are milking good and eating good. D.H.I.A. test show that the s.c.c. counts are coming down on some cows and holding the same on some. Swollen joints have now broken open. Two are healed up. Sno-bird's is draining and will heal up now. It took from Dec. 12 to Jan. 30 for her swollen hock to being healing. The others broke open and began to drain only 4 days after the stray voltage stopped. They can't tell us that swollen hocks isn't a symptom of stray voltage.

Milk production is good. Freckles milked 95 pounds on the last test. An unheard of thing here. 40 milking cows now, 2 of them close to drying time. 9 out of 40 are first time heifers and the herd average is still 55 pounds. Not bad.

As usual, this stray voltage keeps costing us money we don't have. We just got the bill from the experts. Over \$200. We didn't know we had to pay for the testing they did back in January, but I guess we do. Just seems like we'll never be free from costs due to stray voltage.

April 5, 1985

They say that history always repeats itself, and here I am with the same old story. Can't sleep. The cows as usual, are my worry. The more I think about it, the more the pieces fall into place.

It all started again Tuesday night, April 2. Pete came in from the barn and as usual I asked him how milking went. He hesitated and then said not good. Sugar kicked our son. What was wrong? Ten of them were acting strange. They were stomping around bellowing with tails flying. They acted just like they did when we had the stray voltage.

Does the meter still work? I haven't used it since I took it down from my window testing place after they installed the blocker. Pete took the meter and headed for the barn. I tried not to think about it. He came back with good news. Nothing showed up, and the cows seemed to be quiet. I still had this worried feeling though. Later that night it kept going through my head. Then it hit me! The juice was only there at peak hours. Pete wouldn't have found it at 9:30 because that was safe time.

In the morning, much as I hated to, I set up the volt meter in the kitchen window. The ground wire was still there, because we hadn't take it up yet. Sure enough. When 7:00 came the meter started to rise. .34, .49, .92, and up to almost 2 volts! I didn't know what I should do first. Cry? Throw a fit? I did both. As usual, the voltage went back down, the closer to 9:00 it got. As soon as Pete got in I told him about the voltage. As usual, he didn't listen. He headed off for the barn with the meter. I tried to explain that it hadn't been there before when he'd tested. So once again I watched the dial jump from .02 up to 2 volts. The old worries came back. What do I do? I told Pete I was going to call the stray voltage expert again. Pete said that we couldn't afford another bill. Well, once again like before we are arguing again. I asked him what we were going to do about it. Ignore it? Hope it will go away?

Now here it is Friday morning. I'm going bananas again. I can't sleep. I think I've figured it out. About 3 weeks after the blocker was installed, the power truck stopped one day to see if the blocker was still working okay. They told our son they were just checking. I remember the day we installed it. I was watching out the window and also watching the meter. I looked like they must be done since they

appeared to putting things away. The meter said .38 volts. This was normal. I went out to talk to the men and asked if the blocker was in and all. They said things were fine and it was working. I told them my meter in the house hadn't changed, and they didn't say much. Later on, I went in from outside and noticed that the meter read only .02. Boy I was feeling good! Thing went good for a while. Milk production was up, s.c.c. counts were down, and the sores were starting to heal up. The all of a sudden Saddles got mastitis and the treatment didn't work. Pretty soon the other cows started coming down with mastitis. It never occurred to us to check for stray voltage because we had a blocker.

Tonight it came to me. We still registered voltage that day when I talked to the men from the company. ARE THEY ABLE TO TURN THAT BLOCKER OFF AND ON???? Did that man shut it off the day he stopped? We never would have known. We were safe with the blocker, so we no longer checked. What if they can turn it off and on from the main office? Maybe when they found out we were going to sue them, they decided to get us back. Or maybe they are using us as a test. We think everything's well with the blocker. They could say that the whole time the blocker was turned off and we never complained. Stray voltage? Can't be. You're just trying to make some money.

We've had the blocker turned off the whole time, and you never knew the difference.

That would really explain a lot of things. Like the mastitis again. Like the fact we've had the feed tested twice and are feeding them more in hopes of keeping production up. However, nothing helps. The first test after the blocker was installed was wonderful. All the cows were milking with great results. However, now milk production just goes down. Ever since the second test when the man from Lake Region was here, things have gotten worse. Would they really do that? Torture our cows?

Another piece of the puzzle starts to fit. The scientists and the others I've talked with keep bringing up the leg problems that plague people exposed to stray voltage. My legs have gone to pot again. It seems to me that they were all right for a while, but after about 15 minutes in the barn they hurt so bad that I couldn't use the right one at all and had to push myself up with the left. For the last 6 weeks or so, I haven't been able to milk. I've been seeing a chiropractor in hopes of finding relief. However, there's no help there, so I'm going to a specialist on the 15th. Wouldn't that be something if all my leg problems were caused by someone shutting off the blocker? What would we do then? What could we do - take them to court? Yeah like that would do a whole lot of good. Especially with our lawyer. It seems like he's a goof off. He tells us that it takes time. Yeah it takes time - because he doesn't do his job. He doesn't do a thing until we call and complain. Then we get the same old story about how it takes time. If the whole world acted like he did, we'd all be living in caves and chasing our meat down with a stick!

Pete just came down and gave me a dirty look. I bet he thinks that I'm a crazy woman who's obsessed with this stray voltage. I wish I could be more like him. It didn't seem to bother him when we found out the cows were getting it. It doesn't bother him the way it does me. Heck, he can even feel sorry for the Peralas, having a law suit against them and all. Not me. When I remember the times that I tried washing a cow and knocked on the ground by a shock, I can't feel sorry for anyone but those poor cows.

June 17, 1985

Well, some things are still going on around this crazy place. Some time back in April while we were milking, I witnessed Freckles get a shock from her trainer. She jumped, and I could hear the snap clear across the barn. I yelled at my son that the trainers were still on, but he told me they weren't. I certainly wasn't hearing things. So, we got out the meter - just to check. The trainers had over 4 volts in them without being plugged in. How could this be possible? We disconnected the ground wire, with no change. At that point I just happened to touch the wooden post side of the cow. Now we all know that wood does not conduct electricity, but it was hot! Pete came out to the barn to see what was taking us so long. When we told him what we'd found he told us we were crazy. Then we showed him.

He just about hit the roof. He asked me what I was gonna do about it. Call the power company about it again? Get them out here? I don't know any more what I should do. Why does it always have to be my decision? Why is it that I'm always the one that does something? Aren't these his cows too? I finally gave up after finding that all the posts in the barn were hot. One even registered 7 volts. I went inside disgusted. What good does it do to sit in the barn and worry? Why not worry in the house? Finally, needing to do something, I called the stray voltage expert. After I explained the problem, he told me that it was probably induced voltage. He explained that all wires have a halo of current around them - even wires used for underground systems. This current follows the path of least resistance into whatever may be there. There is also no way of getting rid of it.

So, we had the electrician come out to check if that's where the voltage was coming from. Yep, it was induced voltage. The people at the university had told him that such voltage shouldn't affect cows. I explained to them that when we had lifted the unplugged trainer way up in the air the cows seemed to notice the difference. All I received for that explanation was a smile. Another person who thinks I've lost my head. Who knows - maybe they're right. Sometimes I think so myself.

So now what? Do we just leave things the way they are? Forget about it? I just can't do that, so it's back to the headaches again. Again I can't sleep. For 2 weeks it was on my mind. How could the nails in the posts be hot? The men had told us that the voltage was induced from the wires attached to the wood. That got me thinking. If our unseen enemy (stray voltage) liked the wood, wouldn't it like a nice wire that was easy to travel. So I started experimenting. First I used TV cable skinned bare and stapled to the wood. I burned my hands melting the coating off, and banged up my hands putting in the staples, but it worked! My wire was taking the voltage from the wood! Finally I progressed to using regular fence wire and my hand stapler. This all started about 3 days before we tested. By test day, the results were noticeable. When the test came back, they showed dramatic improvements. The s.c.c. counts went down for 11 of the cows, 21 stayed the same, and only 4 went up. Those are the best results thus far. The most surprising thing was the increase in milk production. Of the 38 cows milking, 31 milked more - some increasing by up to 10 pounds a day. Now, does induced voltage bother cows? I'd have to say yes, but then again who will believe me?

On this Sunday morning program, Dr. Schuller talked about how we have all been given gifts - something that each of us can do well. I wonder if my stubbornness about this stray voltage thing is my gift? Is it because of my love for animals that I was chosen to fight this battle? I'd like to believe that I can help other farmers who are having problems with stray voltage. God knows that I've put in my time worrying about it. Maybe that's the point of all this. As I've said before, there's a reason for everything. Maybe I can help others. At least we know now that induced voltage bothers dairy cattle maybe even more than other kinds of stray voltage.

One of our neighbors is having a lot of trouble with his cows too. He was over the other day and borrowed the meter. It showed that stray voltage was present in his barn. We told him to have the power company come out and test it for him. They did, and gave him a snow job when they found it. They told him that stray voltage doesn't exist. That leaves him with sick cows and no idea what to do. Maybe I'll go see if I can help. From what we hear, they're going bankrupt. It sure would help them if the cattle were okay.

Sept. 2, 1985

All is well that ends well, or so they say. I'd have to disagree. The cattle are doing great; I only wish I could say the same for the people. The war we have lived through has taken its toll. Right now, I'm writing down a list of reason that I want a divorce. Pete can't understand why. I guess the man can't remember all the arguments. I guess he can't remember how disappointed I was that he wouldn't accept his share of the problems. He always seemed to believe if he ignored it then it would go away. That's just

not how I approached it. Maybe we're all just tired out. I know I am. We are still worrying over the law suit. We still don't know if we're doing the right thing. Maybe we should just drop it. We are going to win in this situation no matter how the verdict comes out.

We took our son to the VFW club for his birthday. Our neighbor's children were there. They talked to Pete and accused him of trying to get rich off their parents. Boy if they only knew how guilty Pete felt already. With a little persuasion, they could probably get him to testify against me. He seems to think that we're traitors.

Anyways, back to the cows. It still seems that the trainers were part of the answer. During the time I was playing around though, I did a stupid thing and did some wiring without checking the results. Never change anything without testing the results. Raising and disconnecting the trainers is the answer. When the trainers were left disconnected, the results were good on some and not good on others. However, once we raised and disconnected the trainers we got great results. I don't know if it affects all cows this way, but maybe the next test will give us more answers. At any rate, we are now producing quality milk! I never thought we'd see that again. The protein test results are up, and the s.c.c. counts are under 400,000, which is bonus milk!

Nov. 7, 1985

It true that when you live together, the weaker one takes on the characteristics of the stronger one. I must confess to being the weaker one then, because I've become just as blind as Pete, or perhaps I should say just as ignorant. I've been sick. The symptoms themselves should have told me what was wrong. It's not as though they're new to me. The same old things are bothering me: depression, weakness, exhaustion, inability to concentrate, headaches, and various other body aches.

I feel like a traitor. Here I am thinking of myself as somewhat of an expert on stray voltage. All the same signs have been there, just not as clearly cut as before. I half-heartedly checked a couple times, without ever getting much of a reading. I guess though, that the reading was higher than it should of been considering the magic blocker. I guess I chose to ignore it. Yesterday, I finally had to face it. Much as I hated to, I got out the meter and set it up on the outside wire. Boy am I getting good at that! As the morning progressed, the meter showed what I knew it would - the cows were getting it again. At 9 a.m. it went from .03 to .21. By 10:42 it read 1.46. So now once again the meter decorates my kitchen window.

Once again Pete and I are arguing. When he saw the meter in the window, the same look crossed his face. I even hate to bring up the subject of stray voltage again. He never believes that it can be all that bad for the cows. Even after I show him the different readings, all he say is, "Well so what? A little bit isn't going to hurt them." If he isn't convinced of what stray voltage does after seeing it with his own eyes, what chance do we have in court?

As I said, the signs were there, out in the barn. Our son even noticed some of them. Several of the cows have sores again. Sherry, Spice, and Diane stand with their heads pressed down against the cement as though they have bad headaches. The s.c.c. count took a huge leap with 12 cows showing a rise. We've been breeding and breeding the same cows with no luck. Even hormone shots didn't work. The guys are also complaining that the cows are not eating again. D.H.I.A. records show a big drop in production per cow too. Once again we have to ship. When will we ever be rid of stray voltage?

As always, it's up to me to call the lawyer. I also called over to the electric company again to find out what's going on. If they even talk to me after getting the notice that we're suing them. I have a feeling that all the court thing is going to do is make us look like fools. All I can say is that I'd better not be in the courtroom when Pete testifies. I get so mad it's unbelievable. His attitude about stray voltage is beyond my comprehension.

Nov. 8, 1985

Gee isn't life great?!!!! I just came down here again after watching the old meter climb. Fun thought. I disconnected the ground wire in the barn, so it shouldn't get into the cows. It, meaning electricity, has to be in the ground, not in the ground wires like they're trying to tell us. It is for fact in the ground itself. The very ground we live on. And I can prove it.

All I have to do is see different cows in different parts of the barn. They twitch their tails and shift their feet simultaneously. You check the meter, and sure enough the stray voltage is there. It's always there in the background waiting to catch you off guard. It's not going to anymore. I don't care if everyone thinks I'm crazy. I'm going to win. It's not going to keep torturing my cows.

Nov. 23, 1985

We tested again yesterday. I wonder what the results will be? Some of the cows are down, but then when you have stray voltage that's to be expected.

This time at least, it seems that the voltage is not so high. It began before deer hunting. We've taken the ground wires loose, and it's helped. The ground, wires which were actually supposed to keep them safe, were actually picking up juice from the ground and bringing it into the water lines. No wonder those cows were busy shifting their feet and twitching their tails.

I think maybe that there is hope in sight. I know that I've said that before, but I now have hope that we can end this stray voltage problem once and for all. There is a company from St. Louis, Mo., named the Blackburn Company. They have an electronic grounding system which they say reduces stray voltage, both a.c. and d.c., to almost nothing. The way I understand it, this system will also help reduce voltage in the homes that are within 200 feet of the barns. It's all very interesting. They use a computer to check for stray voltage. It is so quick, and it discovers any little thing that might show up. This is the test that showed the stray voltage was coming into the barn through the grounding system.

The people from Blackburn are very nice. I've talked to many of them, trying to convince them to install their system free. In exchange for the free installation, everyone in Minnesota will know how good it is.

It is all so strange. I attended a meeting about stray voltage. There were representatives there from the U of M and 3 power companies, physicists, vets, and others. No one even mentioned the Blackburn system. Yet when I talked to their main office, I was told that other power companies were paying the farmers to install the Blackburn system. How come we in Minnesota aren't aware of this. All I know is that if we install their system and it works, EVERYONE will know about it.

I talked to another neighbor last night. His family was one of them that frowned us for suing our neighbors insurance company. They acted really snotty about the whole situation and pretty much insinuated that we were making up problems. Now, they are having the same problems. Almost all their cows have mastitis, and nothing is helping. Does that ring a bell? I really feel for him. I know what it's like. I told him not to wait, and to get the power company out there right away. The longer you wait, the less chance you'll have to save those cows. It won't get better, it will only get worse. He says that it has to get better, or he will ship them all. I can't say I blame him. We know how bad it is.

After talking with the neighbor, it seems that the vets still haven't learned a thing. They're still out there treating. It seems not to dawn on them that if the cows aren't responding maybe there is another reason. However, as the vets told us, they "don't treat the cause, only the symptoms". I think maybe it's time they wizened up!

The story of this farm is an example of the tragic experience of dairy farmers and their struggle with the effects of stray voltage. This farm is no longer in operation and many health problems plague the family. None of the family lives on the farm today.

SPECIAL STUDY 1001

PHYSICAL CONDITIONS DOCUMENTED BY RESIDENTS IN "REGION X"

This study involves a region near a transmission line corridor. The cases listed are between 1600 meters and 200 meters from the transmission line corridor.

Running north and south through the region and within 100 feet of each other are two alternating current (AC) electric transmission lines. One transmission line is 115 KV and the other is 65 KV. In addition natural gas pipe lines and telephone lines are buried in the area of investigation. Telephone lines, in general, will not introduce electrical energy into the environment, but electrical currents in the earth will often be on buried telephone cables. Natural gas pipelines buried in the earth will often be required to have either active or passive cathodic protection. These pipelines will not only be good paths for electrical currents in the earth but, also and especially, active cathodic protection can introduce direct currents into the earth.

The general physical characteristics of the region are that of rolling hills, rivers, streams and near surface aquifers. Although measurements of earth conductivity were not made, it is believed to be high in much of the region.

Electricity seems to affect animals and people in various ways, and many of these ways are not understood. Both animals and people vary in their sensitivity to electricity, and the effects vary according to the location of the electricity. There is an unusual occurrence taking place among people and animals that live within this area we are identifying as "Region X". The information for each case is documented and provided by individuals living at various locations within this region. The information has also been verified by others knowledgeable of the area.

CASE 1

The respondent is a professional (employment service). Is a female in her 30's and has lived in the region for 18 years.

Symptoms observed:

Tingling or numbness in arms or legs
Frequent headaches
Frequent flu-like or cold symptoms
Vision problems
Feeling bloated / retaining body fluids
Excessive fatigue
Frequent irritability
Frequently feeling anxious
Often feeling under stress
Weakness & pain in legs
Forgetfulness
Allergies
Problems with menstrual cycle

Symptoms observed by other household members:

Frequent flu-like or cold symptoms
Frequently feeling anxious
Forgetfulness
Allergies
Arthritis - lowerback

CASE 2

The respondent is disabled, was previously a Tool die Maker, Inspector, and Maintenance worker. Is a male in his 60's and has lived in the region for 45 years.

Symptoms observed:

Frequent headaches
Vision problems
Excessive fatigue
Often feeling under stress
Weakness & pain in legs
Forgetfulness
Allergies
Arthritis

Symptoms observed by other household members:

Tingling or numbness in arms or legs
Frequent headaches
Feeling bloated / retaining body fluids
Excessive fatigue
Frequent irritability
Frequently feeling anxious
Often feeling under stress
Weakness & pain in legs
Forgetfulness
Allergies

Additional Comments

A leading medical doctor out of Germany didn't think what this gentleman has is true M.S. Several other doctors have expressed this same opinion. He was diagnosed as having M.S. at one of the nations leading hospitals. He is now unable to walk or stand by himself. He can't transfer himself from one place to another. He can't see to read. Many people cannot understand his speech. He is finding it increasingly difficult to feed himself, so his wife feeds him.

CASE 3

The respondent is a Clerk of the Courts (government). Is a female in her 40's.

Symptoms observed:

Tingling or numbness in arms or legs
Frequent headaches
Feeling bloated / retaining body fluids
Excessive fatigue
Frequent irritability
Frequently feeling anxious
Often feeling under stress
Forgetfulness
Allergies
Problems with menstrual cycle

Symptoms observed by other household members:

Frequent headaches
Frequent flu-like or cold symptoms
Problems with breathing

Feeling bloated / retaining body fluids
Excessive fatigue
Frequently irritability
Frequently feeling anxious
Often feeling under stress
Weakness & pain in legs
Forgetfulness
Allergies
Problems with menstrual cycle
Pain in joints
Pain in feet & ankles

CASE 4

The respondent is a clerk - cashier. Is a female in her 20's.

Symptoms observed:

Tingling or numbness in arms or legs
Frequent headaches
Vision problems
Problems with breathing
Feeling bloated / retaining body fluids
Frequently irritability
Frequently feeling anxious
Often feeling under stress
Weakness & pain in legs
Problems with menstrual cycle
Lyme arthritis

Symptoms observed by other household members:

Frequent headaches
Vision problems
Frequent irritability
Frequently feeling anxious
Often feeling under stress
Weakness & pain in legs

CASE 5

The respondent is a disabled man in his 50's. He has lived in this region for 23 years.

Symptoms observed:

Tingling or numbness in arms or legs
Vision problems
Problems with breathing
Excessive fatigue
Weakness & pain in legs
Forgetfulness

Investigative Comments:

Both Mr. and Mrs. seem to be disoriented as to time and dates. Mrs. could not remember when the well was installed - thought 1967 - in fact it was 1985. They have a small business that they now need help with; making change, dealing with public, keeping books, etc. Mr. was once a capable Machinist,

actually thought of as a genius. Now, he admits to being unable to think a project through - even simple ones. Indicated he had to get help to build a trailer for his son - he had built many before. This gentleman suffers from thought pattern loss, loss of depth perception - can't focus or tell the distance of objects. He indicated that this has been coming on for some time. He was diagnosed with M.S. in 1975.

CASE 6

The respondent is a School Bus Driver. Is a male in his 60's.

Symptoms observed:

Tingling or numbness in arms or legs
Problems with breathing
Feeling bloated / retaining body fluids
Excessive fatigue
Weakness & pain in legs
Forgetfulness
Allergies
Rash on hands and arms
Cancer

CASE 7

The respondent is a Farmer and Factory Worker. Is a male in his 40's and has lived in this region for 14 years.

Symptoms observed:

Tingling or numbness in arms or legs
Frequent headaches
Frequent flu-like or cold symptoms
Vision problems
Problems with breathing
Feeling bloated / retaining body fluids
Excessive fatigue
Frequent irritability
Frequently feeling anxious
Often feeling under stress
Weakness & pain in legs
Forgetfulness
Allergies
Excessive stomach problems

Symptoms observed by other household members:

Tingling or numbness in arms or legs
Frequent headaches
Frequent flu-like or cold symptoms
Vision problems
Problems with breathing
Feeling bloated / retaining body fluids
Excessive fatigue
Frequent irritability
Frequently feeling anxious
Often feeling under stress
Weakness & pain in legs

Forgetfulness
Allergies
Problems with menstrual cycle
Excessive stomach problems

Additional Comments:

These symptoms have been coming on slowly over the years, but in the last two years it has come to where they feel they have to try to find a cure because it is getting to the point where it is hard to function. The whole family has had unusual amounts of stomach ailments. Similar symptoms run through the whole family, age seems to be no factor.

CASE 8

The respondent is a retired female in her 70's, and has lived in this region for 42 years.

Symptoms observed:

Excessive fatigue (at night after a day of work)
Forgetfulness (slight)

CASE 9

The respondent is a Dairy Farmer. Is a male in his 30's and has lived on this farm for 33 years.

Symptoms observed:

Tingling or numbness in arms or legs
Problems with breathing
Excessive fatigue
Frequent irritability
Weakness & pain in legs

Symptoms observed by other household members:

Mother has lupus
Father has had a mild stroke

Symptoms observed among cows in barn:

Multiple or recurring mastitis (not responding to treatment)
Breedback difficulties
High somatic cell counts

CASE 10

The respondent is a Dairy Farmer. Is a male in his 40's, and has lived on this farm for 20+ years.

Symptoms observed:

Tingling or numbness in arms or legs
Frequent flu-like or cold symptoms
Vision problems
Problems with breathing
Excessive fatigue
Often feeling under stress
Weakness & pain in legs
Forgetfulness
Unable to sleep well

Sore joints

Symptoms observed by other household members:

Tingling or numbness in arms or legs

Excessive fatigue

Weakness & pain in legs

Forgetfulness

Symptoms observed among cows in barn:

Uneven, incomplete and/or slow milkout

Poor milk production

Multiple or recurring mastitis (not responding to treatment)

Cows reluctant to enter barn and/or stalls

Breedback difficulties

Cow production peaking early and not holding

Cattle kicking milkers off

High somatic cell counts

CASE 11

The respondent is a Dairy Farmer. Is a female in her 40's, and has lived on this farm for 20 years.

Symptoms observed:

Tingling or numbness in arms or legs

Frequent headaches (severe)

Frequent flu-like or cold symptoms

Vision problems

Problems with breathing

Feeling bloated / retaining body fluids

Excessive fatigue

Frequent irritability

Frequently feeling anxious

Often feeling under stress

Weakness & pain in legs

Forgetfulness

Allergies

Problems with menstrual cycle

Stiff neck

Swollen back muscles

Back pain

Dry - mouth, nose, and throat

Symptoms observed by other household members:

Tingling or numbness in arms or legs

Frequent headaches

Frequent flu-like or cold symptoms

Vision problems

Problems with breathing

Feeling bloated / retaining body fluids

Excessive fatigue

Frequent irritability

Frequently feeling anxious

Often feeling under stress

Weakness & pain in legs

Forgetfulness
Allergies
Stiff neck
Swollen back muscles
Back pain
Dry - mouth, nose, and throat

Symptoms observed among cows in barn:

Uneven, incomplete and/or slow milkout
Poor milk production
Poor water consumption
Multiple or recurring mastitis (not responding to treatment)
Cows reluctant to enter barn and/or stalls
Breedback difficulties
Cow production peaking early and not holding
Swollen legs and joints
Dancing of cattle back and forth in stalls
Cattle kicking milkers off
Cattle pressing their noses against stall pipes, water cups or cement curbs
High somatic cell counts

Symptoms also observed among calves:

Poor water consumption
Swollen legs and joints
Calves and young stock pressing their noses against stall pipes, water cups or cement curbs

Additional Comments:

According to the respondent, all of the household members went to receive medical treatment for the above complaints. They were told they were nuts and put on uppers. Eight years ago the youngest boy was doing well in math, over night he lost his ability to do math and never gained it back. All household members have a problem with spots in front of their eyes - black, yellow and blue. They also have a problem with a hard swollen spot just below the ribs in the center, sometimes it's a little to the left. The respondent herself has chest pain. Her husband has a heart murmur. This all started about 10 years ago. Her husband also has a curvature of the spine, this started about 5 years ago. The respondents back bothers her constantly, and she gets swollen glands in the groin and arm pits. Her husband gets swollen glands under his arm pits. They also have experienced tunnel vision.

The cattle also get swollen glands. The cows glands swell in rear flanks, under jaw, and on sides behind the front legs. Their hip joints also swell. The cows get sores on their heels above the hooves. Many calves are born deformed or weak. Some are born dead. Some have white spots in their eyes when born. Some appear normal when born but within a few weeks the ankle joints and knees swell, they loose weight and die. The calves that do live grow poorly. The respondent has seen times where the cows throw up, and yet has been told by veterinarians that cows don't throw up.

INVESTIGATION OF REGIONAL HEALTH PROBLEMS NORTH AND SOUTH OF "REGION X"

On 3 different occasions, a preliminary investigation of the electromagnetic (EM) characteristics of parts of the region north and south of Region X was accomplished. In addition information concerning health of animals and humans was collected as well other pertinent information.

Measurements provided the following data: 60 Hz currents are present in the earth at all locations where measurements were made. Although currents were in all directions in the horizontal plane, The largest currents appeared, in general, to be more east-west than north-south. At certain locations the

predominant direction was north-south, however. Direct currents (DC) in the earth are dependent on a number of sources including chemical processes, the earth-atmosphere electrical system, cathodic protection equipment, rectification of AC and equipment such as transformers. Understanding the meaning of the numbers obtained in DC measurements is more difficult due to variations in chemical composition from point to point in the earth and materials used for measuring probes. Measurements of DC, consequently, can indicate only relative conditions. The most interesting result was an apparent association between AC and DC. An oscillation of the DC was present in measurements between two remote grounds as well as between the neutral-ground and a remote ground. The period of oscillation varied between 5 and 12 sec. The magnitude of the oscillation was found to be dependent on the magnitude of the measured AC. For example between two remote grounds, where the AC potential was on the order of 50 mv, the oscillation was only a few percent, whereas between a neutral and a remote ground, where the AC potential was approximately 8 volts, the oscillation of the DC ranged between 0 and its maximum value. In experimental work in other regions, introducing AC into the earth through a ground rod produced a similar oscillation in the DC. A strip chart recording on one farm north of Region X provides an example of the oscillation of the DC potential as well as information on the spikes and other variations. 60 Hz AC magnetic fields ranged from more than 25 mg under the 65 KV line to approximately 5mg under small distribution lines. At distances up to 300 feet from the distribution lines the 60 Hz fields ranged between .2 and .3 mg. 60 Hz electric fields were also present in the region of lines, underground cables and pipelines. The fields were strongest at the ground surface, reaching a zero point approximately 3 feet above the surface and increasing again with height. Through the use of a battery powered oscilloscope, one could observe the general frequency characteristics and shape of the AC. Significant differences existed from one place to the next. The wave form varied from being nearly square, to being triangular, to nearly sine shaped and often with harmonics and radio frequencies (the fundamental frequency being 60 Hz).

CONCLUSIONS

Both DC and AC are present in the earth throughout the region. Because of the large cross sectional area available for current flow the magnitudes of these currents are difficult if not impossible to absolutely define. The magnitudes of 60 Hz magnetic fields at large distances from transmission and distribution lines support the model of sheets of AC in all directions present in the earth. The general direction was horizontal, sometimes more likely to be perpendicular and other times more likely to be parallel to transmission and distribution lines. Measurements reveal that humans and animals live in EM fields and are exposed to EM energies which come both from direct radiation and from conduction through the earth. These EM energies from conduction through the earth are a complex array of frequencies ranging from DC to 60 Hz with many of its harmonics to spikes with rise times in the range of 20 microseconds to radio frequency. Significant and severe health problems have occurred and are occurring in this region which are perceived by residents of the area and some professionals as being extremely unusual and as having an environmental cause. Analyses of the water and air have not provided any answers to the cause of the health problems.

The studies related to EMs and health have been conducted throughout the world since the 1930's have consistently found associations between many health effects and EM energy. Although limited information is available the complexity and rapid changes of the EM energy to which living organisms are exposed appear to have a greater association with health effects than single frequency, constant levels of EM energy. Since living systems depend upon both chemical and electrical energies for good health, consideration must always be given to effects potentially caused by each. The health problems common to this region such as the neurological disabilities, the various types of cancer, heart attacks and chronic fatigue have been and are associated with EM energy environments. Survey information from many farms in other regions associate the level of health effects with certain physical and weather conditions as well as with the advertent changes of the EM parameters in the region of the farms. Documentation from people living in this regional area supports these associations between physical and weather parameters and state of human and animal health. The amount of EM energy reaching living organisms through the earth is related to the physical parameters of the earth and the electrical circuits

in the living organism can be and are related to atmospheric conditions. These associations would support the probability of an EM connection for the health problems.

Logic would suggest the postulate that, for this case, EM energy emanating from the above ground lines and electrical currents in the earth are associated with the unusually health problems of both humans and animals. Other contributing factors cannot be ruled out but the predominant energy capable of these effects is EM. The presence and locations of substations, electrical transmission/distribution system, of ground and surface water and of underground pipelines produces the EM environment often associated with health problems. Similar environmental and EM conditions exist in other areas of the state and country where severe health problems have been documented.

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HISTORY OF EVENTS ON THE LUSTY FARM 1992-1994

4/14/92	Utility company hooks grounds to earth. 6 years prior, primary neutral grounds are disconnected for majority of that period.
3/15/93	Beginning of test period.
3/24/93	Disconnection of grounds in the afternoon.
3/31/93	Connection of grounds in the afternoon.
4/8/93	Disconnection of grounds in the afternoon.
4/14/93	Connection of grounds in the afternoon.
4/15/93	End of test period.
6/22/93	Power outage occurs on farm.
12/93	High number of cows getting Leukemia. Sore teat ends are a severe problem.
10/9/94	Utility pole fire at neighbor's farm and utility repaired system.

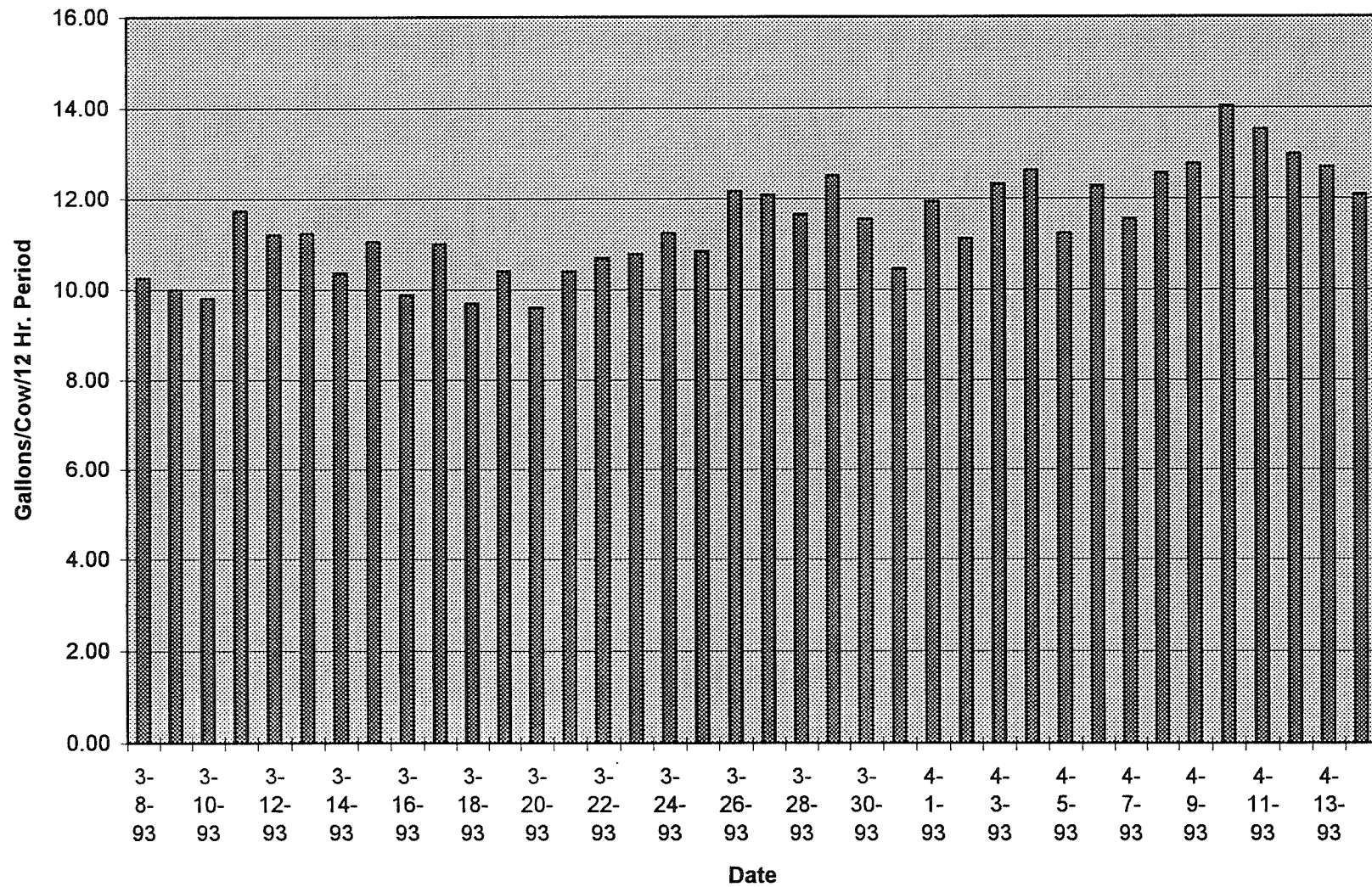
Water Consumption

date	cows	water		
4/3/92	28.00	527.00		18.82
4/4/92	28.00	440.00		15.71
4/5/92	28.00	420.00		15.00
4/6/92	28.00	453.00		16.18
4/7/92	28.00	470.00		16.79
4/8/92	28.00	357.00		12.75
4/9/92	28.00	514.00		18.36
4/10/92	28.00	531.00		18.96
4/11/92	28.00	436.00		15.57
4/12/92	28.00	462.00		16.50
4/13/92	28.00	405.00		14.46
4/14/92	28.00	482.00		17.21
4/15/92	28.00	366.00		13.07
4/16/92	28.00	407.00		14.54
4/17/92	28.00	380.00		13.57
4/18/92	28.00	360.00		12.86
4/19/92	28.00	371.00		13.25
4/20/92	28.00	403.00		14.39
4/21/92	28.00	491.00		17.54
4/22/92	28.00	402.00		14.36
4/23/92	28.00	469.00		16.75
4/24/92	28.00	384.00		13.71
4/25/92	28.00	395.00		14.11
4/26/92	28.00	415.00		14.82
4/27/92	28.00	445.00		15.89

Water Meter Reading
PM

Water Meter Reading	Date	Time	Gallons of Water	Milking Cows	Dry Cows	Gallons Per Cow
130401.00	3-8-93	8:00PM	256.00	19.00	6.00	10.24
130789.00	3-9-93	8:00PM	250.00	19.00	6.00	10.00
131183.00	3-10-93	8:00PM	245.00	19.00	6.00	9.80
131622.00	3-11-93	8:00PM	293.00	20.00	5.00	11.72
132040.00	3-12-93	8:00PM	280.00	20.00	5.00	11.20
132472.00	3-13-93	8:00PM	281.00	20.00	5.00	11.24
132884.00	3-14-93	8:00PM	259.00	20.00	5.00	10.36
133328.00	3-15-93	8:00PM	276.00	20.00	5.00	11.04
133759.00	3-16-93	8:00PM	247.00	20.00	5.00	9.88
134189.00	3-17-93	8:00PM	275.00	20.00	5.00	11.00
134597.00	3-18-93	8:00PM	242.00	20.00	5.00	9.68
135026.00	3-19-93	8:00PM	260.00	20.00	5.00	10.40
135443.00	3-20-93	8:00PM	240.00	20.00	5.00	9.60
135890.00	3-21-93	8:00PM	270.00	21.00	5.00	10.38
Unknown	3-22-93	8:00PM	278.00	21.00	5.00	10.69
136827.00	3-23-93	8:00PM	280.00	21.00	5.00	10.77
137304.00	3-24-93	8:00PM	292.00	21.00	5.00	11.23
137790.00	3-25-93	8:00PM	282.00	21.00	5.00	10.85
138300.00	3-26-93	8:00PM	316.00	22.00	4.00	12.15
138795.00	3-27-93	8:00PM	314.00	22.00	4.00	12.08
139305.00	3-28-93	8:00PM	303.00	22.00	4.00	11.65
139825.00	3-29-93	8:00PM	325.00	22.00	4.00	12.50
140339.00	3-30-93	8:00PM	300.00	22.00	4.00	11.54
140830.00	3-31-93	8:00PM	274.00	22.00	4.00	10.46
141332.00	4-1-93	8:00PM	310.00	23.00	3.00	11.92
141814.00	4-2-93	8:00PM	289.00	23.00	3.00	11.12
142340.00	4-3-93	8:00PM	320.00	23.00	3.00	12.31
142854.00	4-4-93	8:00PM	328.00	23.00	3.00	12.62
143344.00	4-5-93	8:00PM	292.00	23.00	3.00	11.23
143874.00	4-6-93	8:00PM	319.00	24.00	2.00	12.27
144370.00	4-7-93	8:00PM	300.00	25.00	1.00	11.54
144888.00	4-8-93	8:00PM	314.00	24.00	1.00	12.56
145422.00	4-9-93	8:00PM	319.00	24.00	1.00	12.76
146011.00	4-10-93	8:00PM	351.00	24.00	1.00	14.04
146542.00	4-11-93	8:00PM	338.00	24.00	1.00	13.52
147086.00	4-12-93	8:00PM	324.00	25.00	0.00	12.96
Unknown	4-13-93	8:00PM	317.00	25.00	0.00	12.68
148160.00	4-14-93	8:00PM	302.00	25.00	0.00	12.08

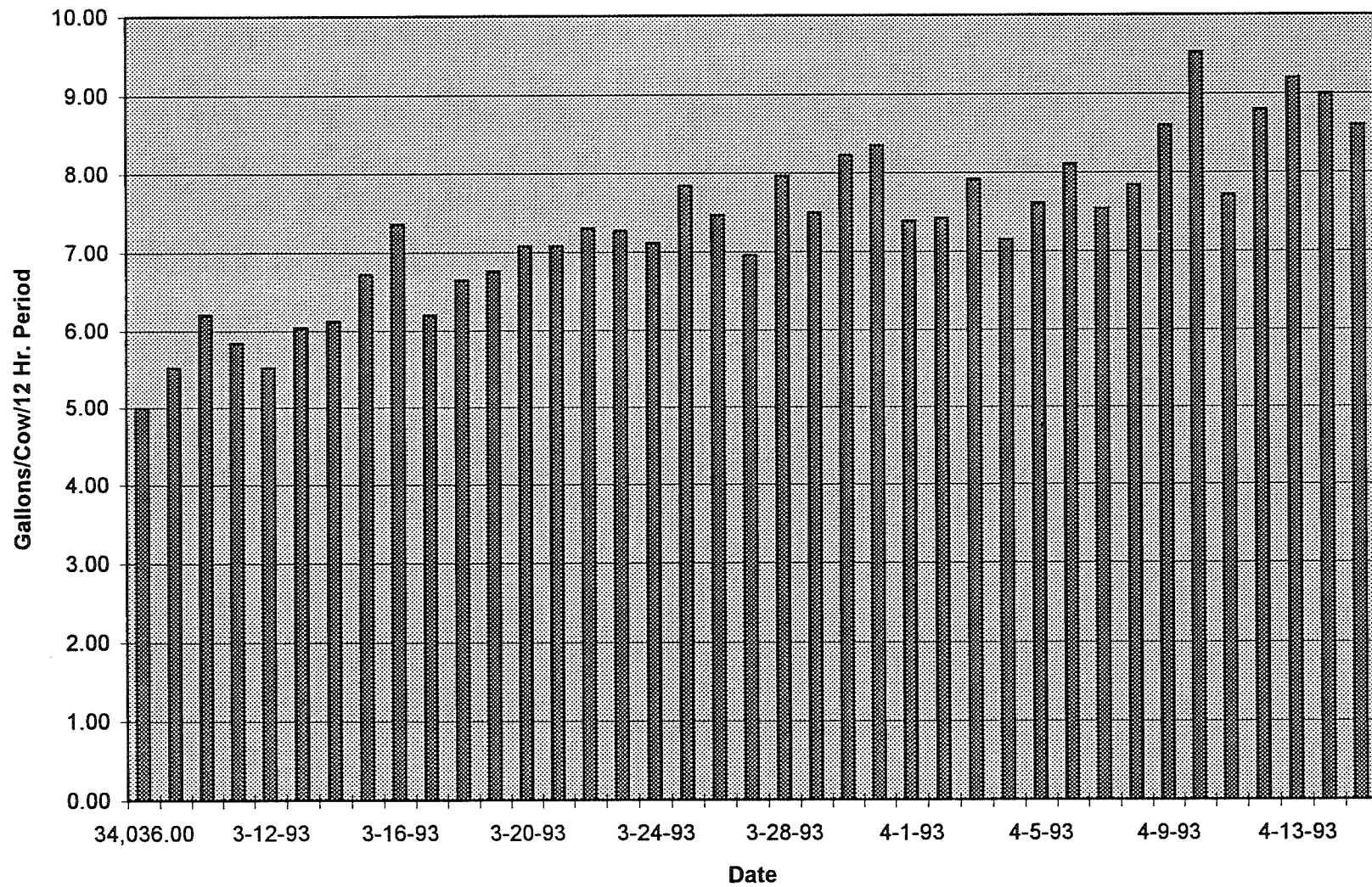
Water Consumption on the Lusty Farm



Water Meter Readings
AM

Water Meter Reading	Date	Time	Gallons of Water	Milking Cows	Dry Cows	Gallons Per Cow
130145.00	3-8-93	8:00AM	125.00	19.00	6.00	5.00
130539.00	3-9-93	8:00AM	138.00	19.00	6.00	5.52
130938.00	3-10-93	8:00AM	149.00	19.00	6.00	5.96
131329.00	3-11-93	8:00AM	146.00	19.00	6.00	5.84
131760.00	3-12-93	8:00AM	138.00	20.00	5.00	5.52
132191.00	3-13-93	8:00AM	151.00	20.00	5.00	6.04
132625.00	3-14-93	8:00AM	153.00	20.00	5.00	6.12
133052.00	3-15-93	8:00AM	168.00	20.00	5.00	6.72
133512.00	3-16-93	8:00AM	184.00	20.00	5.00	7.36
133914.00	3-17-93	8:00AM	155.00	20.00	5.00	6.20
134365.00	3-18-93	8:00AM	166.00	20.00	5.00	6.64
134766.00	3-19-93	8:00AM	169.00	20.00	5.00	6.76
135203.00	3-20-93	8:00AM	177.00	20.00	5.00	7.08
135620.00	3-21-93	8:00AM	177.00	20.00	5.00	7.08
136080.00	3-22-93	8:00AM	190.00	22.00	4.00	7.31
136547.00	3-23-93	8:00AM	189.00	21.00	5.00	7.27
137012.00	3-24-93	8:00AM	185.00	21.00	5.00	7.12
137508.00	3-25-93	8:00AM	204.00	21.00	5.00	7.85
137984.00	3-26-93	8:00AM	194.00	21.00	5.00	7.46
138481.00	3-27-93	8:00AM	181.00	22.00	4.00	6.96
139002.00	3-28-93	8:00AM	207.00	22.00	4.00	7.96
139500.00	3-29-93	8:00AM	195.00	22.00	4.00	7.50
140039.00	3-30-93	8:00AM	214.00	22.00	4.00	8.23
140556.00	3-31-93	8:00AM	217.00	22.00	4.00	8.35
141022.00	4-1-93	8:00AM	192.00	22.00	4.00	7.38
141525.00	4-2-93	8:00AM	193.00	23.00	3.00	7.42
142020.00	4-3-93	8:00AM	206.00	23.00	3.00	7.92
142526.00	4-4-93	8:00AM	186.00	23.00	3.00	7.15
143052.00	4-5-93	8:00AM	198.00	23.00	3.00	7.62
143555.00	4-6-93	8:00AM	211.00	23.00	3.00	8.12
144070.00	4-7-93	8:00AM	196.00	24.00	2.00	7.54
144574.00	4-8-93	8:00AM	204.00	25.00	1.00	7.85
145103.00	4-9-93	8:00AM	215.00	24.00	1.00	8.60
145660.00	4-10-93	8:00AM	238.00	24.00	1.00	9.52
146204.00	4-11-93	6:30AM	193.00	24.00	1.00	7.72
146762.00	4-12-93	8:00AM	220.00	25.00	0.00	8.80
147316.00	4-13-93	8:00AM	230.00	25.00	0.00	9.20
147858.00	4-14-93	8:00AM	225.00	25.00	0.00	9.00
148375.00	4-15-93	8:00AM	215.00	25.00	0.00	8.60

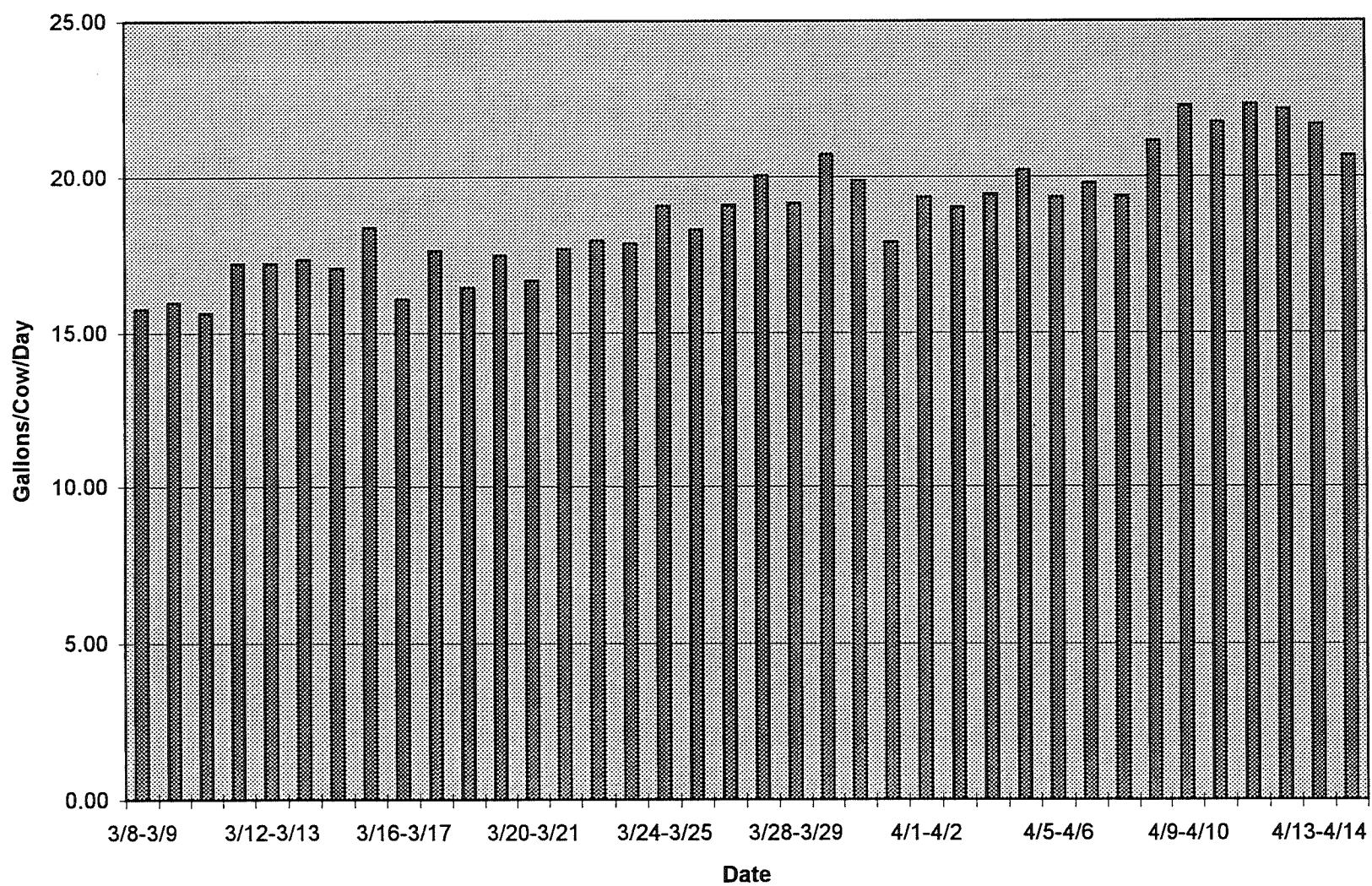
Water Consumption on the Lusty Farm



Water Meter Readings
Over 24-Hour Time Period

Water Meter Reading	Date	Gallons of Water	Milking Cows	Dry Cows	Gallons Per Cow
130539.00	3/8-3/9	394.00	19.00	6.00	15.76
130938.00	3/9-3/10	399.00	19.00	6.00	15.96
131329.00	3/10-3/11	391.00	19.00	6.00	15.64
131760.00	3/11-3/12	431.00	20.00	5.00	17.24
132191.00	3/12-3/13	431.00	20.00	5.00	17.24
132625.00	3/13-3/14	434.00	20.00	5.00	17.36
133052.00	3/14-3/15	427.00	20.00	5.00	17.08
133512.00	3/15-3/16	460.00	20.00	5.00	18.40
133914.00	3/16-3/17	402.00	20.00	5.00	16.08
134365.00	3/17-3/18	451.00	20.00	5.00	18.04
134766.00	3/18-3/19	401.00	20.00	5.00	16.04
135203.00	3/19-3/20	437.00	20.00	5.00	17.48
135620.00	3/20-3/21	417.00	20.00	5.00	16.68
136080.00	3/21-3/22	460.00	22.00	4.00	17.69
136547.00	3/22-3/23	467.00	21.00	5.00	17.96
137012.00	3/23-3/24	465.00	21.00	5.00	17.88
137508.00	3/24-3/25	496.00	21.00	5.00	19.08
137984.00	3/25-3/26	476.00	21.00	5.00	18.31
138481.00	3/26-3/27	497.00	22.00	4.00	19.12
139002.00	3/27-3/28	521.00	22.00	4.00	20.04
139500.00	3/28-3/29	498.00	22.00	4.00	19.15
140039.00	3/29-3/30	539.00	22.00	4.00	20.73
140556.00	3/30-3/31	517.00	22.00	4.00	19.88
141022.00	3/31-4/1	466.00	22.00	4.00	17.92
141525.00	4/1-4/2	503.00	23.00	3.00	19.35
142020.00	4/2-4/3	495.00	23.00	3.00	19.04
142526.00	4/3-4/4	506.00	23.00	3.00	19.46
143052.00	4/4-4/5	526.00	23.00	3.00	20.23
143555.00	4/5-4/6	503.00	23.00	3.00	19.35
144070.00	4/6-4/7	515.00	24.00	2.00	19.81
144574.00	4/7-4/8	504.00	25.00	1.00	19.38
145103.00	4/8-4/9	529.00	24.00	1.00	21.16
145660.00	4/9-4/10	557.00	24.00	1.00	22.28
146204.00	4/10-4/11	544.00	24.00	1.00	21.76
146762.00	4/11-4/12	558.00	25.00	0.00	22.32
147316.00	4/12-4/13	554.00	25.00	0.00	22.16
147858.00	4/13-4/14	542.00	25.00	0.00	21.68
148375.00	4/14-4/15	517.00	25.00	0.00	20.68

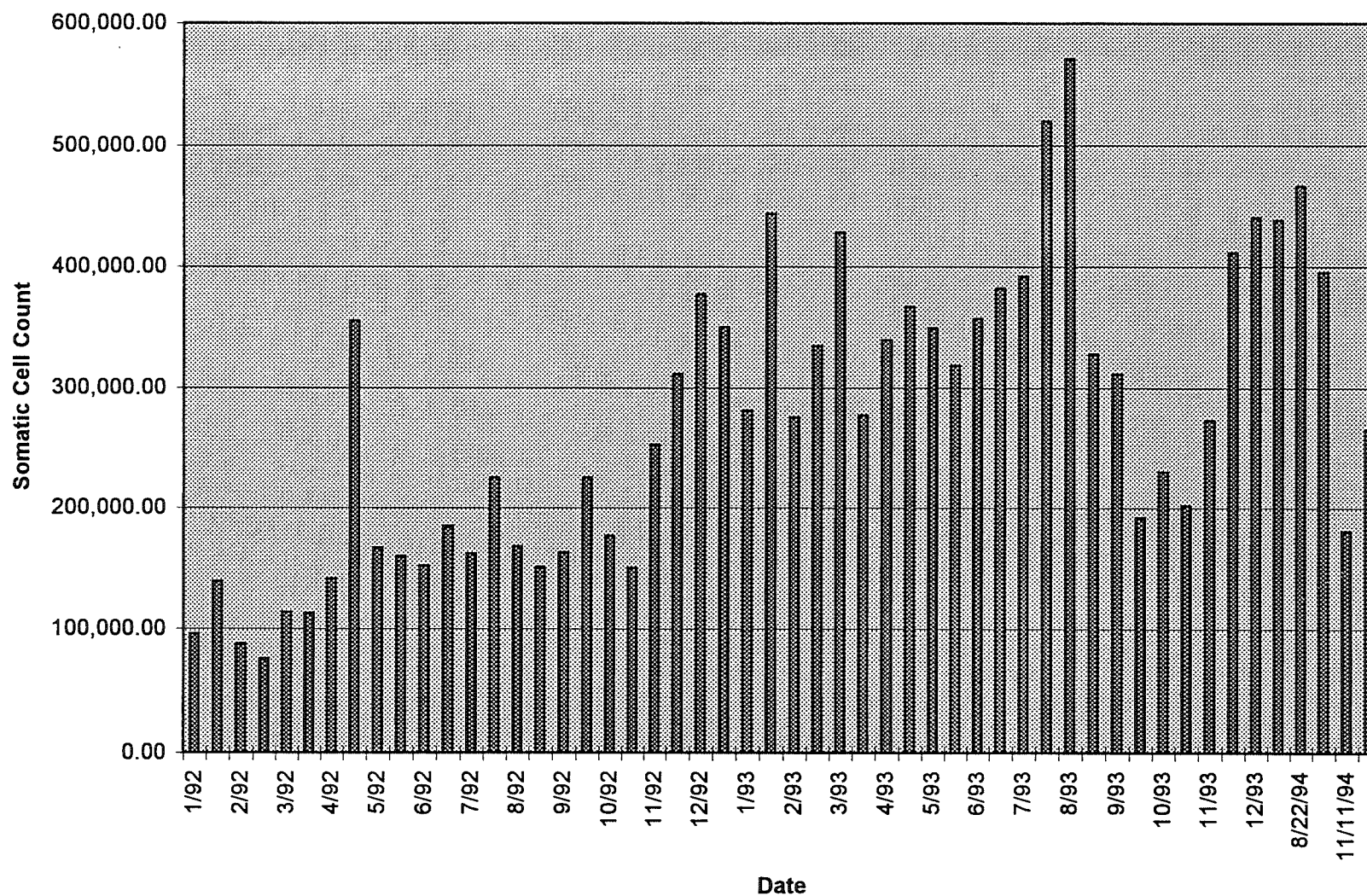
Water Consumption on the Lusty Farm



Date	Protein	SCC	BF
1/92	318.00	96,000.00	364.00
1/92	325.00	139,000.00	368.00
2/92	329.00	88,000.00	366.00
2/92	326.00	76,000.00	361.00
3/92	328.00	114,000.00	357.00
3/92	335.00	113,000.00	372.00
4/92	328.00	141,000.00	379.00
4/92	328.00	355,000.00	391.00
5/92	320.00	167,000.00	377.00
5/92	333.00	160,000.00	342.00
6/92	335.00	152,000.00	322.00
6/92	328.00	185,000.00	344.00
7/92	320.00	162,000.00	328.00
7/92	326.00	225,000.00	323.00
8/92	327.00	168,000.00	333.00
8/92	323.00	151,000.00	344.00
9/92	334.00	163,000.00	372.00
9/92	347.00	225,000.00	383.00
10/92	352.00	177,000.00	382.00
10/92	348.00	150,000.00	380.00
11/92	337.00	253,000.00	382.00
11/92	338.00	311,000.00	384.00
12/92	335.00	377,000.00	387.00
12/92	332.00	350,000.00	391.00
1/93	331.00	281,000.00	384.00
1/93	332.00	443,000.00	386.00
2/93	334.00	275,000.00	390.00
2/93	335.00	334,000.00	393.00
3/93	339.00	428,000.00	396.00
3/93	339.00	277,000.00	405.00
4/93	335.00	339,000.00	393.00
4/93	329.00	367,000.00	404.00
5/93	329.00	349,000.00	379.00
5/93	347.00	318,000.00	365.00
6/93	345.00	357,000.00	356.00
6/93	336.00	382,000.00	361.00
7/93	332.00	392,000.00	0.00
7/93	338.00	520,000.00	0.00
8/93	337.00	571,000.00	0.00
8/93	327.00	328,000.00	0.00
9/93	332.00	311,000.00	0.00
9/93	335.00	192,000.00	0.00
10/93	322.00	230,000.00	0.00
10/93	316.00	202,000.00	0.00
11/93	317.00	273,000.00	0.00
11/93	319.00	411,000.00	0.00
12/93	323.00	440,000.00	0.00
12/93	327.00	438,000.00	0.00
8/22/94	365.00	466,000.00	365.00

8/27/94	379.00	395,000.00	379.00
11/11/94	339.00	181,000.00	397.00
11/30/94	337.00	266,000.00	398.00

Somatic Cell Count on the Lusty Farm



A QUESTIONNAIRE ABOUT HUMAN AND ANIMAL WELL BEING

Please, would you complete the following questions and return the questionnaire to the address indicated at the bottom of the fourth page.

I. If you have observed any of the following symptoms among your cattle, check those symptoms which you have observed.

- ☐ 1. uneven, incomplete and/or slow milkout
- ☐ 2. poor milk production
- ☐ 3. poor water consumption
- ☐ 4. multiple or recurring mastitis (not responding to treatment)
- ☐ 5. cows reluctant to enter barn and/or stalls
- ☐ 6. breedback difficulties
- ☐ 7. cow production peaking early and not holding
- ☐ 8. swollen legs and joints
- ☐ 9. cattle dancing back and forth in stalls
- ☐ 10. cattle kicking milkers off
- ☐ 11. cattle pressing their noses against stall pipes, water cups or cement curbs.
- ☐ 12. high somatic cell counts
- ☐ 13. high veterinarian bills
- ☐ 14. leukemia/anemia
- ☐ 15. inability to maintain weight in cold weather
- ☐ 16. poor hair coat, constant lice problems
- ☐ 17. inflamed sphincter valve (even among un milked heifers)
- ☐ 18. tanish discharge under eyes, nostrils, and ears
- ☐ 19. stress rings on the hoofs (excessive growth)
- ☐ 20. heifers and cows have trouble getting up (legs seem numb)
- ☐ 21. tough hides which result in bent and broken injection needles
- ☐ 22. breeding problems, such as: silent heats, absorptions, and spontaneous abortions
- ☐ 23. immune system failures resulting in Chlamydia, pneumonia, and Bovine Viral Diarrhea (BVD)
- ☐ 24. excessive teeth found in feeders and feedbunk

<u>You</u>	<u>2nd person</u>	<u>3rd person</u>
<input type="checkbox"/> 11. allergies	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 12. neurological illness (e.g., Multiple Sclerosis)	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 13. ears ringing	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 14. pressure behind the eyes	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 15. unexplained nausea	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 16. unexplained general feeling of not being well	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 17. rheumatoid arthritis	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 18. high incidence of non-malignant body tumors	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 19. occurrence of malignant body tumors	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 20. (females) feeling bloated/retaining body fluids	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 21. (females) problems with menstrual cycle	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 22. having an illness that medical professionals cannot diagnose	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 23. occurrence of heart related ailments	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 24. other _____		

Is anyone else in your household experiencing these symptoms?
☐ yes ☐ no (If yes, check those items under the second and/or third person columns that are applicable)

If you or any member of your household have any of these symptoms, do they tend to occur with the times you observe health symptoms among you cattle or pets?

☐ yes ☐ no ☐ did not observe symptoms among pets or cattle

Have any members of your household been regularly treated for any of the symptoms checked above? ☐ yes ☐ no

If yes, which ones? _____

IV. If you have experienced any of the following problems with equipment or machinery at your present home/farm, please indicate those observed by checking the appropriate space.

- ☐ 1. incandescent lamp failures (sometimes in groups, explosions)
- ☐ 2. unusually high rate of battery failure
- ☐ 3. radio and TV set failure (non-lightening related)
- ☐ 4. increasing motor burnouts
- ☐ 5. occasional shocks from water lines or faucets

QUESTIONNAIRE ON FARM VOLTAGES

Following are questions about electricity on your farm and changes that may have been made in dealing with it. This information is being gathered by The Electromagnetic Research Foundation (a corporation of dairy farmers) in response to legislation by the State of Minnesota. In case you do not have all of the information requested, simply fill in the information you do have and return it to the person indicated at the end of this form. If more space is required, you may use the backs of the questionnaire pages.

A. MEASUREMENTS OF ELECTRICITY:

1. Maximum primary neutral to earth voltage, DC and AC:
a. _____ DC b. _____ AC.
2. Minimum primary neutral to earth voltage, DC and AC:
a. _____ DC b. _____ AC.
3. Maximum secondary neutral to earth voltage, DC and AC:
a. _____ DC b. _____ AC.
4. Minimum secondary neutral to earth voltage, DC and AC:
a. _____ DC b. _____ AC.
5. Measurements of current on the primary grounding wires:
a. _____ DC b. _____ AC.
6. Measurements of current on the secondary grounding wires:
a. _____ DC b. _____ AC.
7. Cow contact voltages and contact points between which measurements were made:
a. _____ DC Where made? _____
b. _____ AC Where made? _____
8. Indicate any other measurements that were made that you feel are important:

B. ELECTRICAL CHANGES AND THEIR EFFECTS:

1. Briefly indicate any changes in electrical wiring made on your farm.

a.

b.

c.

2. Briefly indicate changes made in the electric utility system.

3. Has an electrical transmission line recently been added near your farm?

a. ☐ Yes b. ☐ No

4. Are there any recent changes in natural gas or oil pipelines near your farm?

a. ☐ Yes b. ☐ No

5. If you answered "yes" to either of the two preceding questions, did you notice any changes in your livestock's behavior, health or production following these changes?

a. ☐ Yes b. ☐ No If yes, please indicate, as precisely as possible, what these changes were including any documentation you might have.

6. If you answered "yes" to either B. 4 or 5, did you notice any changes in the health of persons living and/or working on your farm?

a. ☐ Yes b. ☐ No If yes, please indicate, as precisely as possible, what these changes were including any documentation you might have.

7. Also if you answered "yes" to either B. 4 or 5, did you notice any changes in your electrical equipment?

a. ☐ Yes b. ☐ No If yes, describe these changes.

C. CHANGES IN GROUNDING OF THE NEUTRALS:

1. Have any changes been made in the grounding of equipment, the secondary neutral or the primary neutral on your farm?

a. ☐ Primary neutral (kind of change):

b. ☐ Secondary neutral (kind of change):

c. ☐ Electrical equipment (kind of change):

2. If you checked either a, b, or c, in the preceding question, have you observed any changes in animal behavior, health or production, human health or electrical equipment after changes were made?

a. ☐ Yes b. ☐ No If yes, specifically indicate these changes and provide documentation where possible.

D. MITIGATION:

1. Did you at any time have (please check items that apply):

a. ☐ Neutral isolator?

b. ☐ Equipotential plane in your barn?

c. ☐ Electronic grounding system?

d. ☐ Any other system?

2. If you checked either a, b, c, or d, in the preceding question, have you observed any changes in animal behavior, health or production, human health or electrical equipment after changes were made?

a. ☐ Yes b. ☐ No If yes, specifically indicate these changes and provide documentation where possible.

E. ELECTRICAL PROBLEMS DISCOVERED ON THE FARM:

1. While uncovering stray voltage effects, problems have sometimes been discovered in the farm's or neighboring farm's electrical circuits. Are you aware of any such problems on your farm?

a. ☐ Yes b. ☐ No If yes,

1) describe the problem.

2) Did solving the problem affect the animal behavior, health and production or human health?

a. ☐ Yes b. ☐ No If yes, indicate how.

2. Please provide any additional information that you have which would be useful in understanding this problem.

Optional:

Name _____

Address _____

Thank you for taking time to complete this questionnaire. If no other person is designated, please return the completed form to Dr. Duane Dahlberg, Department of Physics, Concordia College, Moorhead, MN 56562.