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STRAY VOLTAGE
INTERIM REPORT
MINNESOTA DEPARTMENT OF AGRICULTURE

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INTRODUCTION:

Electricity has become an irreplaceable energy source in our society. The Quality of electrical energy is such as to make it Unusually versatile. Electrical energy has its negative characteristics as well. An obvious hazard is the electric shock which has the potential to kill both animals and humans. Strict electrical codes have been the key to reducing the possibility of a deadly shock. Low voltage steady state and transient alternating currents (AC) have also been shown to have detrimental effects especially on confined livestock. The effects, the methods of determining the potential for effects, and the solutions have been reported in many different periodicals. The basic measurement that is suggested for determining the probability for a problem is the neutral to earth AC potential. The belief is that this potential is the maximum that can access the livestock in the confined area and therefore can predict the possible magnitude of the problem. The solutions that have been offered and implemented basically attempt to limit the AC potential from accessing the animal. Two suggestions by university personnel and power suppliers are devices that isolate the power supply neutral from the farm neutral and the equipotential plane. The purpose of both is to prevent AC potentials from causing currents to flow through the livestock.

In more recent years, people have been asking about the possible effects from electric and magnetic fields, electromagnetic fields, and ions. Thus far, such research in this country is neither complete nor conclusive. For many reason dairy farmers have become especially concerned with the problems which they are observing in their dairy herds. They believe that their cattle and even their families are being affected by electrical sources in their barns and in some cases in their homes. We could dismiss this concern as simply an illusion brought about by difficult economic times and poor management. The concern and the physical problems however, are far to widespread to leave the response with economics

or poor management. As a consequence of the farmers concerns, the Minnesota State Legislature, in its wisdom, provided funds to assess the problem.

Under contract with the Minnesota Department of Agriculture, my charge has been to study the effects and abatement of animal health and production problems created by stray voltage.

MEASUREMENT METHODOLOGY:

AC and direct current (DC) potentials and currents were measured with the traditional instrumentation, including VOM, VTVM, digital meter, and oscilloscope. DC fields were measured with the electric fieldmill. A variety of other instruments were also used to support the findings. One problem that has not been resolved is the calibration of the fieldmill.

FINDINGS:

The preliminary findings are based on visitations and measurements at 27 farms, 4 rural machine and repair shops, and 3 homes in the central and western parts of the state. The majority of farms had installed isolation devices, equipotential planes, or both. Management ranged from good to excellent on all of the farms. The farmers had attempted various feeding programs, supplements, and milking procedures to improve the dairy herd health and milk production. Some farmers had autopsies performed on cows that had developed physical problems which the farmers believed to be caused by stray voltage. In fact the most satisfying experience has been the observation ingenuity of the farmer in attempts to deal with the problem.

Alternating currents and potentials exist between various conducting portions of the barn. The magnitudes vary according to electrical usage on the farm; isolation or no isolation; construction of the barn, including such properties as equipotential planes; and some unknown factors. AC is present as electromagnetic energy

usually referred to as induction fields. They also vary in magnitude and in general are not considered to be a significant source of electrical energy.

Studies of the AC in the ground, revealed that there is no place--whether around the farm yard, in fields, or in pasture areas-- where AC potentials and consequently currents do not exist. The earth has become a large sink of AC energy. In addition, a study of the characteristics of the AC in the ground, indicates a complex and skewed wave form which is continuously changing. At times, the basic 60Hz wave form is nearly masked out by other frequencies. Other higher frequencies, predominantly one MHz are also present in the ground.

Direct currents and DC potentials exist in the barns between various conducting components. Some of these electrical energies are caused by the galvanic or battery action in and around the barn. Measurements also indicate additional DC potentials which cannot be associated with chemical reactions. These potentials have been identified as being the result of an electric field present in and around the barn. The DC field appears to be caused by a positive charge buildup near or at the surface of the ground. The magnitude of the field is not the same all over; but seems to be associated with water and concrete.

Preliminary measurements of magnetic fields have not revealed any significant anomalies; but some differences exist which will require further investigation.

At the same time that electrical parameters were being considered, it seemed useful to investigate the impacts of dietary supplements that could be associated with the problems. Even though these investigations are preliminary, the substances selenium, calcium, and sugar based minerals seem to be connected with the problem.

The conditions present on the farms are--at least--the problems described in the literature. Those problems which the farmers speak of first are the long milking time caused by an inability of the cows

to let down their milk; low milk production; high somatic cell count; outbreaks of mastitis, which seemed resistant to antibiotics; breeding problems; and behavioral problems, such as stomping, kicking, fear and dislike of the milking machine, and refusal to enter the stall. Other problems that appeared to be related were difficulty in walking and getting up. Some farmers speak of their cows being unsteady as they leave the barn. Leg ulcers or sores, some of which will not heal, were very common. Eating habits are erratic. The cows at times will eat very well where as other times they eat very little, refusing to clean the floor of the manger area. In some cases, the cows have difficulty maintaining an adequate weight, even though their milk production is not especially good. On nearly all these farms the veterinary costs are high.

* For the people the acute problems are tingling feet (children speak of is as something tickling or pinching their feet--especially when barefoot), tired and aching legs, general fatigue after spending a few hours in the barn or shop, aching and swollen knees, dizziness, headaches, *temporary loss of vision, disorientation, and loss of depth perception. There may be chronic problems as well; but they are difficult to assess within the time period of this study. *- have caused this to happen -*

DISCUSSION:

Recording a variety of AC and DC parameters for periods of time has revealed one correlation--although not perfect. The problems have some relationship with the earth's conductivity or the availability of DC current. In addition, experimentation has shown an association of the symptoms with magnitude of DC electric field. Measurements during the milking process also indicated that DC currents were involved in the discomfort of the cow and probably with milk letdown. In the majority of barns visited, isolation and/or the equipotential plane is used to supposedly eliminate the classical AC problem. Measurements indicated that in most of these barns very little AC could access the cows. In addition, cattle standing on steel plates and touching no other conductor were as

susceptable to the problems as unisolated barns and farms. These conditions also suggest the involvement of the DC electric field, AC fields, and very small currents.

AC potentials and currents are associated with the problems as well. The basic research performed by the universities only involved the "shock effect" of AC, which indicated that currents up to 4-6ma do not cause the physical effects that farmers have observed in their cattle. The effects of long term, small currents, have not been researched and could lead to some entirely different results.

The data collected also indicates a correlation of the intensity of the problems and saturation of the soil. The wetter the conditions, the greater the problems. The dryer, the lesser the problems. In mid-winter when there is deep frost, conditions are improved. The spring of the year, as the ground thaws, is the time of the most significant problems for both humans and animals. There is also some correlation with humidity; but this may be indirect.

PRELIMINARY CONCLUSIONS:

The problem is wide spread, affecting both humans and animals on at least dairy farms, hog farms, and rural machine repair shops.

There is no question of the association of electricity with the problems encountered by both humans and animals.

The ground seems to be the major carrier of the electricity.

The electricity appears to be interaction with the central nervous system, which among other things is creating stress on animals and humans. There may also be a migration of ions in the bodies.

The sources of AC are quite evident. They are the earth itself through the grounding system, the neutral wire connected to

ground and electromagnetic fields produced by induction.

The DC sources is a more complex issue. One source is the battery or galvanic effect brought about by the presence of different metals and good electrolytes. This source does not appear to be a prime source of the problem. There are also natural telluric currents in the earth which could contribute to the charge. These currents are, however, relatively small. All DC power lines have some ground return. The anodes and cathodic protectors, for example, on oil and natural gas pipelines provide a source of DC to the ground. In addition, some of the AC present in the ground can be rectified by water and earth materials to provide another source of DC.

In all experimentation, AC and DC were found to be intimately associated.

Attempts to relieve or reduce the problems have not met with much success. In barns with equipotential planes, a 12 volt battery, was connected so as to neutralize the DC field present in the barn. The cows improved for about two days by then reverted back to their former characteristics. A case of a barn without an equipotential plane--the isolated barn ground was connected to an unused well. Again for a few days the cows showed considerable improvement, after which conditions became worse.

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