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Measurement of Stray Current in Cows

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ABSTRACT

A method is described that enables the measurement of small stray currents in ambulatory cows in commercial dairies.

It is known that current flowing through cows can have undesirable effects.[1] The seriousness of these effects are related to the magnitude, frequency, and path of the current. One technique for determining such currents is to connect a resistor that simulates the resistance of a cow across the external electrical source, and then measure the current through the resistor.[2] A voltage measurement can be made, and the current equals the voltage divided by the resistance.

The measurement of the current through the cow can be made directly on the cow by connecting two electrodes across a part of the cow. The current through a leg can be measured by using two electrodes connected to the hip and the ankle. Electrodes $1'' \times 2''$ of .005 inch brass shim stock placed on the cow with Crest toothpaste as an electrolyte rubbed into the hair and held in place with duck tape works well. The current can be determined by measuring the voltage between the electrodes.

$$i_{leg} = \frac{v_{leg}}{R_{leg}}$$

where R_{leg} is the resistance of the leg. The resistance R_{leg} can be determined by passing a calibration current from an external source through the leg and measuring the voltage between the electrodes.

$$R_{leg} = \frac{v_{leg}}{i_{calibration}}$$

The value of R for a cows leg is about 100 ohms. It is important to check that the amplifiers are operating in their linear region when the calibration and measurements are performed.

If the voltage measuring device has a high input impedance, the resistance of the electrode connections can be neglected. For example, a 10 kilohm electrode resistance will cause less than 1% error for an input impedance of 1 megohm. If the calibration current $I_{calibration}$ comes from a current source of 100 kilohm impedance a contact resistance to

the cow of 1000 ohms will cause less than 1% error in R_{leg}. If only one leg is used the current in only one leg will be measured. The current in all four legs can be measured simultaneously. Current flow up the front legs and down the back legs will be distinguishable from current flowing to the mouth or teats, and out the legs. Currents in a leg as small as 10 microamperes can be measured.

The voltage across electrode pairs can be transmitted by radio[3] to the observer so the cow can move freely and the currents through the cow monitored. The over-all result is that the cow is now an active participant in determining the source of the stray current, and is effectively given a "voice" to inform the human of the presence of a current. Since the human is not exposed to hazardous voltages in searching for stray current, this technique should enable dairymen to become more directly involved in searching for the source of stray current.

[1] *Effects of Electrical Voltage/Current on Farm Animals: How to Detect and Remedy Problems*, USDA Agricultural Research Service, Agriculture Handbook Number 696, December 1991.

[2] Chapter 5: "Detection and Measurement," *Effects of Electrical Voltage/Current on Farm Animals: How to Detect and Remedy Problems*, USDA Agricultural Research Service, Agriculture Handbook Number 696, December 1991.

[3] A modified video camera remote microphone system manufactured by Sima Products Corporation can be used.