



Stray Voltage in Animal Housing: Introduction

Clinical Findings

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Prevention and Control

The term stray voltage has been used to describe a special case of voltage developed on the grounded neutral system of a farm. If this voltage reaches sufficient levels, animals coming into contact with grounded devices may receive a mild electric shock that can cause a behavioral response. At voltage levels that are just perceptible to the animal, behaviors indicative of perception (eg, flinches) may result with little change in normal routines. At higher levels, avoidance may result. The term stray voltage is often applied incorrectly to other electrical phenomena such as electric fields, magnetic fields, and most recently, electric current flowing in the earth.

A great deal of research on the effects of stray voltage on farm animals has been conducted over the past 40 yr. The effects of stray voltage are seen most often in dairy cattle. The most sensitive cows (<1%) begin to react to 60 Hz electrical current of 2 milliamps (measured as the root mean square average or rms) applied from muzzle to hooves or from hoof to hoof. This corresponds to a contact voltage level of ~1 volt (60 Hz, rms). As the voltage and current increase, a larger percentage of cows react with behavioral responses that become more pronounced. Numerous studies have documented avoidance behaviors at levels above the first reaction threshold. The median avoidance threshold for 60 Hz current flowing through a cow is ~8 milliamps (4-8 volts, rms). This response assumes that the cow comes into contact with objects that have different voltages and that this voltage causes sufficient current to flow through the cow. Even when the threshold is exceeded, not all the animals respond behaviorally all the time, nor do they exhibit the same signs; however, as the voltage increases, signs in the herd become more widespread and uniform.

In most situations, cows are less sensitive to current and more sensitive to voltage than are people. While the resistance of cow and human tissues is similar, the contact resistance is generally lower for cows than for humans, particularly in wet environments. The resistance of a cow's body plus the contact resistance with the floor is commonly estimated as 500 ohms for a cow standing on a wet floor. Cows standing on a dry surface typically produce 1,000 ohms resistance. Cows standing or lying on dry bedding have a resistance many times higher than this. The resistance of a human can be as low as 1,000 ohms for wet hand-foot contact to >10,000 ohms for dry hand-foot contact. The contact voltage to produce sensation can therefore be higher for humans than for cows, depending on the conditions of the contact points.

The scientific evidence strongly suggests that there is no relationship between behavioral responses to stray voltage and physiologic or hormonal responses. There is no apparent relationship among behavioral modifications, milk production, and animal health. The only studies that have documented adverse effects of voltage and current on cows had both sufficient current applied to cause aversion and forced exposures (ie, animals could not eat or drink without being exposed to voltage and current). It is typical for voltage levels to vary considerably at different locations on a farm. Decreased water and/or feed intake or undesired behaviors result only if current levels are sufficient to produce aversion at locations that are critical to daily animal activity, eg, feeders, waterers, and milking areas. If an aversive current occurs only a few times per day, it is not likely to have an adverse effect on cow behavior. The more often an aversive voltage occurs in areas critical to cows' normal feeding, drinking, or resting, the more likely it is to affect cows.

Recent research has investigated the effects of high frequency or short duration transient voltages on cows. The main sources of these transient voltages on a farm are improperly installed electric fences and switching of electrical devices. The very high frequency switching transient pulses decay quickly and do not travel far from their source. Exceptions to this are electric fences, which produce a powerful electric impulse designed to control animals. Improper installation of these devices can cause these pulses to appear in unintended areas on the farm. As the duration of the pulse gets shorter, more voltage and current is required to perceive an electrical pulse.

Although stray voltage problems can also affect beef cattle, pigs, and poultry, they are less frequent because the electric demand in those operations is lower.

Clinical Findings:

No one sign is pathognomonic; a wide variety of signs has been reported in cows exposed to different levels of voltage. Documented signs are behavioral changes and decreased number of drinks of water per day and increased length of time per drink. Amount of water consumed is not affected. Intermittent periods of poor performance, poor milk letdown and incomplete or uneven milk-out, abnormal behavior during milking, increased milking time, refusal of feed or water, increased somatic cell counts in milk, and increased mastitis are signs often attributed by farmers to stray voltage; however, none of these signs were evident in numerous controlled studies. These signs are often caused by other factors, such as abusive cow handling, faulty milking machines, poor milking techniques and hygiene, and nutritional deficiencies. Therefore, animal behavior or other signs cannot be used to diagnose stray voltage problems. The only way to determine if stray voltage is a potential cause of abnormal behaviors or poor performance is to perform electric testing (see below). A thorough investigation of the entire production unit should be conducted to determine other sources of problems.

Signs in pigs are similar, although growing pigs are about twice as resistant to stray voltage as are dairy cows. Continuous exposure via feeders or waterers of up to 5 volt AC had no detrimental effect on fattening pigs. Sows show aggressive behavior, reduced appetite and water consumption, and uneven milking (increased starve-out in litters).

The problem in poultry is not well defined. When birds are raised on the ground, exposure to large voltages (>40 volts AC) is required to deliver detrimental currents on feeders or waterers. Voltages in this range fall outside the definition of stray voltage.

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Diagnosis:

For confirmation, a potential of 2-4 volt (60 Hz, rms) must be measured between 2 points that a cow might contact (point-to-point or cow contact measurement), and some cows should exhibit signs of exposure. This measurement provides the best indication of exposure levels. Voltage levels should be monitored at different times of the day and on different days because the threshold level may be exceeded intermittently. When exposure during milking is suspected, measurements should be made with all electrical milking equipment turned on (both 110 and 220 volt). Although levels of exposure up to 2-4 volts AC are not detrimental, farms on which these levels have been detected should be monitored to ensure that higher levels do not occur intermittently.

Point-to-reference ground measurements can be useful for diagnostic purposes. Cow contact measurements are typically 1/2 to 1/3 of point-to-reference voltage and current levels. A reference ground is established with a 4 ft (1.3 m) copper-clad rod driven into the ground 25 ft (8.5 m) from any grounding rods or electrical equipment. The other contact point is typically the secondary neutral buss in the service entrance panel to the barn or some other part of the grounded neutral system. The voltmeter should have high input impedance with full scale reading of 2-5 volts in 0.1 volt increments. Voltage readings at cow contact points should be made with a 500-1,000 ohm resistor across the 2 measuring leads to the cow contact points in addition to open circuit measurements. Readings without the use of a shunt resistor are meaningless. If >1 volt, 60 Hz rms is detected at the cow contact points, having a qualified electrician and/or the local power supplier evaluate the situation is advisable.

Long, insulated meter leads (6-10 ft [2-3 m]) facilitate measurements on the farm and give a reasonable estimate of 60-Hz electric events, but introduce considerable noise to higher frequency measurements.

The measurement of high frequency events requires proper equipment and careful measurement technique. Details on sensitivity levels and measurement techniques are available through electric power suppliers.

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Prevention and Control:

Most on-farm sources of stray voltage are due to wiring systems that do not meet wiring codes and standards. Deficiencies may include loose or corroded connections, ground faults (shorts), undersized wiring, or wiring damaged by animals, accidents, or moisture. An electrician should examine the system and repair any defects. Voltage produced by non-faulty 240-volt equipment usually indicates the distribution system as the source and is the responsibility of the utility company to examine and correct.

Cows have been shown to resume normal behaviors within 1 day of removal of adverse voltage and current levels. Conditions produced by abnormal behaviors may take longer to resolve but should improve within 1 mo.

Electric systems should comply with wiring codes and standards at all times to protect both animals and people. Whenever suggestive signs cannot be attributed to other causes,

measurements should be taken to determine if a voltage potential exists, and the results recorded for future comparisons. A review of electromagnetic fields and other electrical exposures concluded that there was no evidence to suggest that they are harmful to cows at the typical exposure levels found on farms.

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See Also

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