Stray Voltage and Robotic Milking of Dairy Cows

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Factsheet

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INTRODUCTION

Robotic milking systems depend on voluntary visits by cows to the milking stall. If cows experience electric shocks when visiting the milking stall they are less likely to visit. This Factsheet outlines appropriate testing, correction and prevention options.

STRAY VOLTAGE

The most common source of stray voltage in Canada and the U.S. is neutral current generated by normal power consumption in the grounded neutral electrical distribution system. Electrical distribution in Europe is phase-to-phase and with the rare exception of electric shock from ground faults there is no stray voltage on European farms.

Stray voltage in livestock agriculture is the difference in voltage potential measured between two surfaces that may be contacted simultaneously by an animal. *Stray current* is the electric current that flows through an animal when it makes simultaneous contact with two surfaces that have different electric potentials.

Research indicates that most animals are not affected by low levels of stray voltage, but those that are develop "behavioural avoidance" patterns. Sensitive cows may show mild behavioural avoidance at current exposures exceeding 2 milliamps, corresponding to about 1–2 volts.

In Ontario, metal robotic milking equipment systems are case grounded. Since the metal floor is an integral part of the milking box, the cow is on an "equipotential plane" while in the stall and therefore protected from stray voltage during milking. As cows enter and leave the box there is a "step potential" as one body part, usually a foot, can be in contact with the robot while the other foot touches the surrounding environment.

While there is potential for stray voltage problems on farms with robotic milkers — limited testing on eight farms found voltage ranging from 0–0.4 V — current research indicates this is too low to be of concern.

On several of the farms the floor area beside the milking stall was slatted, providing cows with minimal grounding that alleviates the risk of stray voltage. In barns designed with solid floors, consider building a transition gradient. A transition gradient is an area designed to minimize the step potential as cows approach and exit the robot.

Stray voltage is unique to North America. Proper monitoring and mitigation when required is important to robotic milking installations.

MITIGATION

For a more detailed explanation of testing procedures, causes and solutions see the OMAFRA website www.ontario.ca/omafra or publications by Hydro One. Details on stray voltage testing are found in Hydro One's booklet "Stray Voltage Test Procedure for Electrical Contractors".

TESTING FOR STRAY VOLTAGE

Follow these steps to test a robot site for stray voltage.

- Place a metal plate firmly on wetted concrete at the point where the cow's rear feet will be when entering the existing or proposed robotic milking stall.

Ministry of Agriculture, Food and Rural Affairs

Ontario

- Connect one of the multi-meter leads to this plate.

- Connect the other lead to a clean metal contact on the stall. If the stall is not yet installed, use a long lead or wire to connect to the grounding block in the service entrance panel of the barn.

- Use a high impedance, digital voltmeter with a 300–1,000 ohm resistor between the leads in parallel to the meter or use an oscilloscope that has the added ability to look at short duration spikes.

- Readings taken between the contact points described will represent exposure the cow has when entering the robotic milking stall.

- Since voltage often fluctuates widely during the day take measurements over 24 hours with a recording meter or repeated frequently over the same period with a standard meter. Expect highest readings during times of peak electrical use on the farm and in the neighbourhood.

- Voltage may also fluctuate seasonally so repeat testing may be needed.

Only a few stray voltage problems can be solved with improved grounding or correction of electrical faults. That does not mean these things cannot play a role, but in most cases either an equipotential grid/plane or a piece of separation/correction equipment is needed.

RECOMMENDED OPTIONS

The following section outlines options available to reduce or eliminate stray voltage in robotic milking systems, along with advantages and disadvantages of each.

Equipotential Plane

A welded wire mesh grid, bonded to the robot milking stall and extending into the concrete area on which the cow approaches and departs from the robot, will prevent her from getting a shock when she steps onto the metal floor. If this "plane" ends abruptly the cow is exposed to a front-to-rear hoof shock at the point she steps onto and off of the plane. It is necessary to create a "gradient" that ensures a gradual change in the exposure.

At milking parlour entrances this is done with 3.7 m (12 ft) ground rods driven at a 45° angle at the edge of the grid and bonded to it. Rods are normally spaced 15–30 cm (0.5–1 ft) apart. This gradient reduces the level of voltage between two points over the length of the cow by approximately 50 per cent. As illustrated in Figures 1 and 2 the same gradient can be created immediately beside a robotic milking stall with ground rods driven in a fan shape around the stall at 45° off horizontal.

If the stall includes a holding area and exit lane, consider applying a grid to this area with a welded wire mesh and locate the gradient at the entry and exit points as shown in Figure 3. This would move any mild shock that still occurs to a point further from the stall.

Disadvantages of equipotential planes include that they:

- are difficult to install
- are expensive to retrofit
- only reduce voltage to half on the gradient and may still leave a problem.

One advantage is that they do not have moving parts or require maintenance.

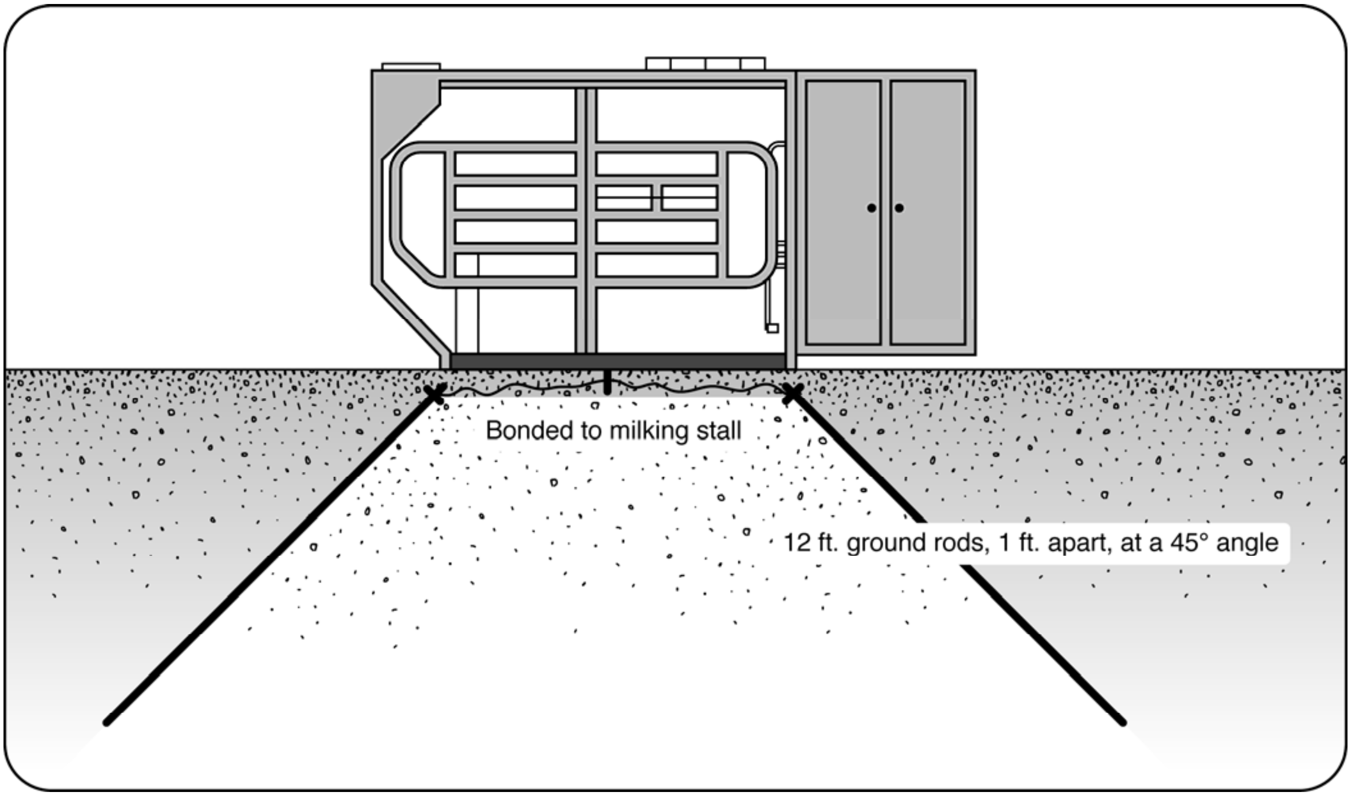

Figure 1. Cross-section view of an equipotential gradient in association with a robotic milking stall.

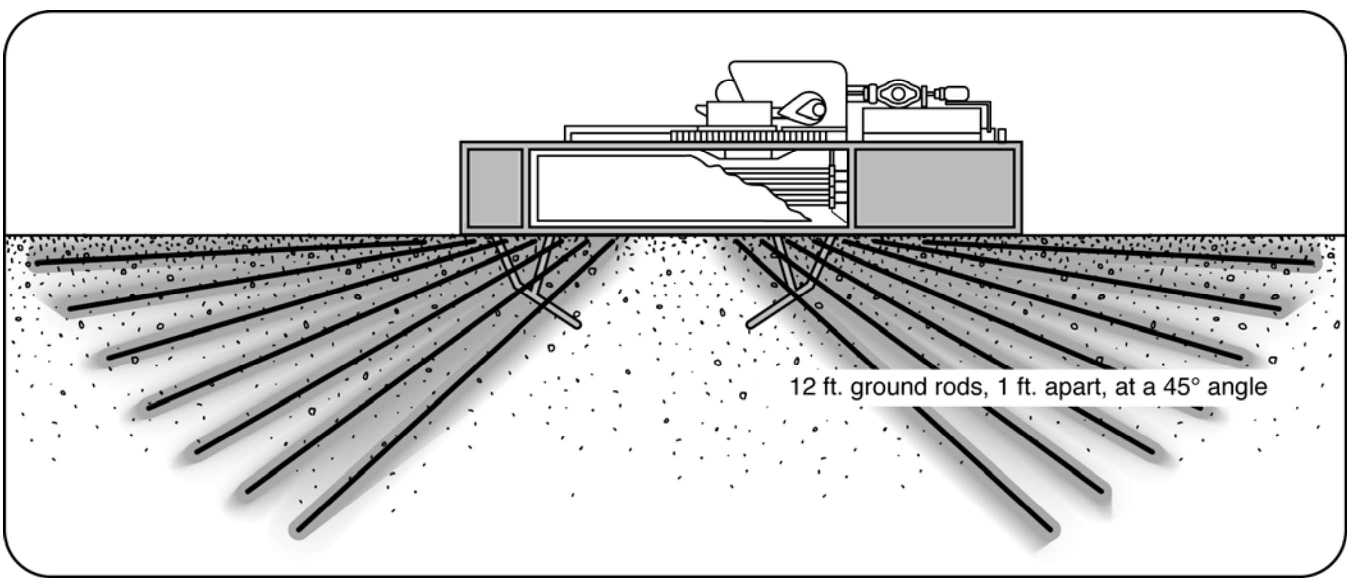

Figure 2. Top view of an equipotential gradient in association with a robotic milking stall.

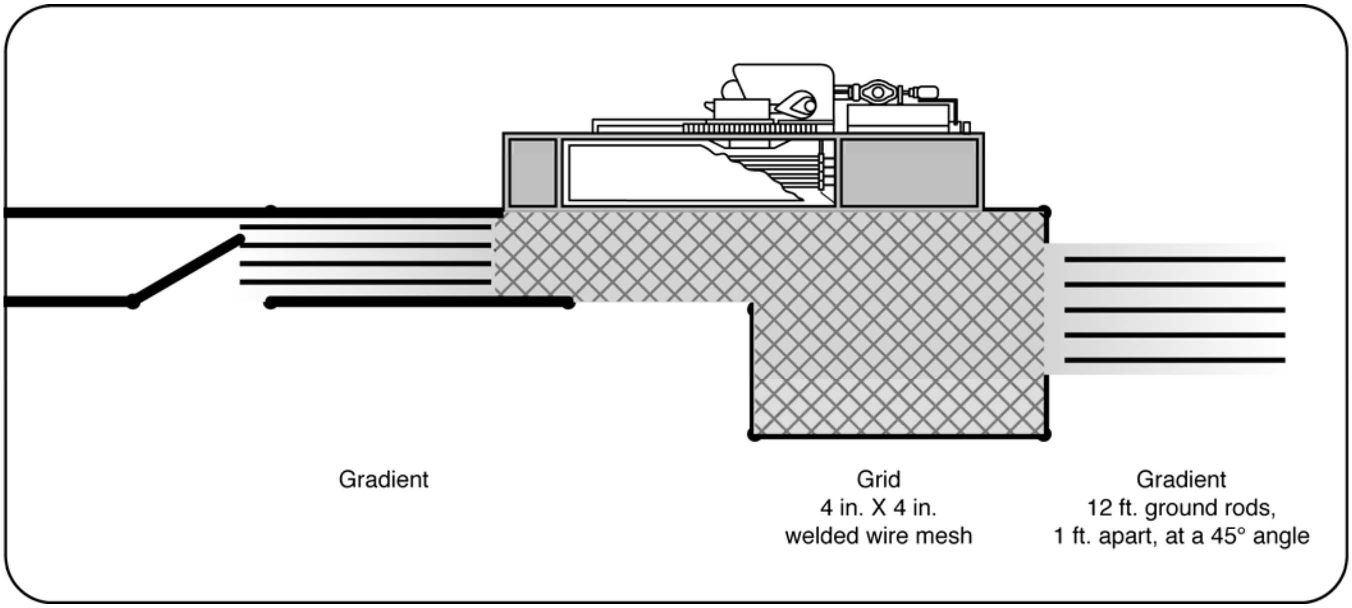

Figure 3. Top view of an equipotential plane and gradient for a robotic milking stall with a holding area and exit lane.

Strategic Use of Slatted Floors

Slatted floors have poor contact with the ground, providing effective isolation. Cows entering a robotic milking stall from a slatted area do not receive a shock since their hind feet are not grounded.

A slatted floor beside the robot also helps keep the area dry and clean, and provides a convenient place to drain washwater and waste milk.

The slatted area needs to be large enough to allow cows to exit the robotic milking stall completely with all four feet on the slatted area before their front feet touch the solid floor. This requires about 1.8 m (6 ft) of slats.

In the transition from the metal floor in the stall to the slatted floor the cow does not get a shock because she is not grounded. In the transition from slats to solid floor she gets no shock because there is no contact with bonded metal.

With no maintenance necessary, this is one of the better solutions. There are, however, two possible disadvantages.

- Observation suggests cows are more comfortable walking on solid floors than slatted ones and would avoid slats if possible. If cows are reluctant to step on to the slats it could be replacing one avoidance problem with another. Using a good quality waffle slat can help solve this potential problem.
- It is costly to add a pit to an existing barn if it is only used to control stray voltage. But in a newly constructed barn a slatted floor area near the robotic milker is a good option.

Hammond Tingle Voltage Filter

The Hammond Tingle Voltage Filter normally reduces the level of voltage by 85 per cent to 95 per cent, which is usually enough to eliminate the problem. For robotic milking the filter is installed on the service entrance panel that supplies the robot with power. It does require complete electrical separation of the grounding system from the neutrals and many electricians find installation difficult. As well, there is currently no manufacturer of this device. It might be possible to find a used filter from those no longer raising cattle. This is a low cost solution, if a used filter and an experienced electrician to install it correctly, can be found.

Ronk Blocker

The Ronk Blocker is essentially the same as a tingle voltage filter but it is installed between the primary and secondary neutral. Like the filter, it results in a percentage decrease only and like separation it does not address on farm sources. Since it is installed at the transformer, the utility must be involved in the installation. There are a number of these devices installed in southwestern Ontario. Distributors can be found on the Internet.

Dairyland Variable Threshhold Neutral Isolator

DEI Variable Threshhold Neutral Isolators also separate neutrals at the transformer. While slightly more costly than the Ronk, it is also slightly more effective because isolation of the neutrals is complete. Like other pole top solutions it does not address on farm sources and requires utility cooperation. Distributors can also be found on the Internet.

OTHER OPTIONS NOT RECOMMENDED

There are at least three other options that are poorer choices than those offered above.

An eastern Ontario company uses **separation devices** that isolate individual sections of stabling from the rest of the grounding system. Since the robotic milking stall involves electrical components and contains current carrying conductors, it must be case grounded. For safety reasons this approach is not recommended.

Isolation transformers can isolate a barn from the primary neutral, but these are expensive and limit future expansion of the service.

Active suppression devices are effective, but very costly.

2009 ONTARIO ENERGY BOARD RULING

In 2009 the Ontario Energy Board ruled that electricity distributors must investigate stray voltage concerns on livestock farms if the farmer can show that stray voltage may be adversely affecting the operation of the livestock farm.

Ruling (paraphrased)

Where an investigation reveals that either:

a. ACC [animal contact current] on the farm exceeds 2.0 mA or
b. ACV [animal contact voltage] on the farm exceeds 1.0 V

the distributor shall conduct tests to determine whether and the extent to which the distributor's distribution system is contributing to farm stray voltage measured on the farm.

Where the tests reveal that the distributor's distribution system is contributing more than 1 mA ACC or 0.5 V ACV to farm stray voltage on a farm, the distributor shall take such steps as may be required to ensure that such contribution does not exceed 1 mA ACC or 0.5 V ACV.

For full details of the decision contact your local electricity distributor or the Ontario Energy Board.

SUMMARY

Electric shocks caused by stray voltage on the robotic milking stall can influence cow behaviour and reduce voluntary use of the automatic milking system. Where testing shows levels are in excess of 1–1.5 V, corrective action is recommended. The most appropriate solution may depend on the voltage level found, the utility's policies and whether it is new construction or renovation.

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