1.1 Causes

Stray voltage on dairy farms can arise from faults in equipment (e.g. electric fence energisers, electrified backing gates, pumps), static build up in certain areas, or problems with the power supply or wiring in the dairy.

Possible causes of stray voltage include:

- Poor electrical grounding at the dairy.
- Incorrect cable sizing especially on high current usage devices such as larger electric motors.
- Insulation breakdown on wiring due to the ingress of moisture, ageing or wear.
- Loose connections and corroded wires.
- Electrical faults in equipment such as submersible pumps or in underground wiring (e.g. wiring under the yard).
- Poor/damaged electric fence insulators or poor electric fence conductor installation can result in fencer pulses appearing in unintended locations.
- Inadequate electric fence grounding.
- Electric fence earth rods too close to the dairy.
- Incorrectly installed or malfunctioning Variable Speed Drives on electric motors.
- Poorly balanced electrical load on the three phase electricity supply.

The system typically used in New Zealand to supply three phase power to farm dairies (and other sites) is the three phase multiple-earthed-neutral (MEN) reticulation system. In a perfect situation, the load across all three phases is balanced, meaning the same load is applied to each phase, resulting in no current flow in the neutral conductor. The dairy will hopefully have been wired to balance the total load as evenly as possible, but in reality a perfectly balanced condition rarely exists and the loading on phases is always changing due to single phase loads in the dairy turning on and off. Whenever an imbalance occurs, current flows through the neutral wire causing small voltage differences in the neutral circuit between the distribution transformer and the dairy building. The neutral is earthed at the transformer and at the dairy so the voltage difference is distributed over the ground surface at the transformer and around the dairy site. If correct safeguard systems are not in place at the dairy (such as an equi-potential-floor) it may be possible for small voltages to appear in concrete or pipe-work in the dairy or yards.

Issues when drenching

Stray voltage can be a problem when the drum containing the liquid and pump is located on a different area of concrete to that in the bail area. The two areas can be at a different earth potential with the drench liquid providing a pathway for an electric current to pass to and through the cow. The cow gets shocked by stray voltage as she is being drenched, with a devastating impact on her behaviour.

This problem is easily avoided by cutting the tubing carrying the liquid and inserting a section of steel pipe that is welded to the bail pipework. The liquid at that time is then in electrical contact with the steel pipework and the voltage is dissipated (see Figure 1).
If you think you may be dealing with a stray voltage problem then take time to observe the cows. The behavioural responses of the herd can be a very good indicator as to the source of the voltage.

Do cows:
- urinate and defecate excessively?
- milk out poorly (due to interrupted milk let down)?
- sniff the ground or the platform and back away/show reluctance to enter the platform?
- sit on the backing gate, mill around, stampede?
- kick at the cluster and the milkers?
- react when an electric motor is switched on?
- dislike crossing certain races or gateways? e.g. bunching up and then running across.
- lap at water rather than drinking (water can be live due to electric fences or electrolysis from the metals in the water)?

Do you:
- have to repeatedly leave the pit to bring cows into the dairy?
- get shocks when you touch the bulk milk tank or milk stand door?
- notice that cow behaviour is worse in very wet or very dry weather?

When observing cows consider other possible reasons for poor behaviour or low milk production, such as poor milking machine set up. If you have identified some of the signs above and can find no other explanation, you should have the farm checked for stray voltage.

1.3 Stray voltage testing
Competent stray voltage investigations require specialised test equipment and a considerable amount of knowledge, skill and understanding of electrical systems. If you believe that there is a problem with stray voltage in your dairy don’t hesitate to hire an expert. You will also need to hire a registered electrician if any changes to the mains wiring are necessary, including any changes to the switchboard earthing system.

There are some simple checks that you can do yourself which may identify the possible source of the stray voltage and provide useful background information for the expert when you call.
**Simple checks**

If you suspect stray voltage in your shed, start by doing some of the following checks and observe the cows over a period of days looking for any accompanying changes in behaviour (it may take time for cows to stop showing signs of fear, even after any stray voltage is controlled).

- Turn off electric fence energisers before the cows enter the yard and leave them off throughout the entire milking.
- Turn off water heaters throughout the milking.
- Avoid hosing down or operating the effluent pump during milking.
- Keep the drenching unit running continuously.

For more about stray voltage testing see Appendix 1.

**1.4 Setting up your farm to prevent stray voltage**

It is preferable to reduce stray voltage by removing (wherever possible) the cause of the stray voltage, such as an electrical fault or poorly installed electric fence energiser. However some sources can never be entirely eliminated and safeguard measures are necessary to minimise stray voltage in the dairy and yard area as much as possible. Some safeguard measures, such as equi-potential floor systems and voltage ramps, are most easily installed when the dairy is under construction, however in some cases corrective measures can be relatively simple to retrofit (for more about measures to guard against stray voltage in new dairies see Chapter 8. New Dairy Design, or contact your local milking machine company). Some will have to be performed by a registered electrician.

Note: Do not tamper with the dairy switchboard electrical earth. Leave any work on the switchboard earth system to a registered electrician.

**Suggested improvements**

Projects to consider

- Ensure that Variable Speed Drives and the electrical motors they control are installed precisely as instructed by the VSD manufacturer. Some VSD manufacturers specify the use of screened power cables between the VSD unit and the electric motor it controls.
- Minimise unbalanced electrical loads.
- Check, and if necessary, improve the switchboard earth system. It may be necessary to increase the number and quality of stakes.
- Install a heavier neutral line having a lower resistance between distribution transformer and dairy.
- Install any deep well pumps well away from the dairy shed.
- Do not use a metal bore liner as an electric fence energiser earth connection.
- Ensure that the electrical fence energiser earth meets the requirements specified by the manufacturer and is at least 20 metres from the switchboard earth, the further away the better.

**Action points**

- If cows for no apparent reason are: avoiding some places or seem nervous, cow flow into the dairy is poor, or they are sniffing the ground and reversing, check for stray voltage.
- Competent stray voltage investigations can be costly so talk to the service provider before you agree to have work undertaken.
- If you experience a painful shock when a metal object is touched this usually indicates a dangerous situation involving defective wiring or equipment. It should be reported to, and corrected by, a competent electrician immediately.
- Ensure all steel pipework in shed is interconnected, including connections to mesh in concrete.
Appendix 1. Testing for Stray Voltage

Testing using equipment

The right equipment and procedures must be used to measure voltage and find the source.

A combination of two basic measurement methods, ‘cow contact point-to-point’ and ‘point-to-ground’, is preferred when troubleshooting for stray voltage problems. Cow contact point measurements can give an indication of exposure levels while point-to-ground measurements provide diagnostic value.

Cow contact point-to-point

Measurements are made with a suitable voltmeter between any two points that a cow could contact simultaneously, such as the entry race and cow platform of a rotary dairy. A 500 ohm resistor must be connected in parallel across the voltmeter probes to simulate the impedance of the cow. A disadvantage of this method is that poor contact resistance and condition of the floor can cause variable readings.

Point-to-reference

With one lead of the tester connected to the “main earth peg” measurements can be taken around the dairy shed to ensure that “earthed” appliances and pipe works are in reality connected to the building earthing system. If it is not meant to be alive earth it.

Connection points

Connections to clean metal surfaces can be made with an electrical clip or clamp. Connections to a concrete floor can be made with a sheet metal plate (100 x 100mm square of stainless steel or copper). The plate can be placed directly on the floor if the surface is wet with manure or urine. If the floor is dry, wet it first. The residual salts in the faeces and urine will help the connection. Alternatively, any conducting solution such as dairy detergent can be used.

Equipment for stray voltage testing

Voltmeters

A suitable voltmeter must:

- be capable of distinguishing between alternating current (ac) and direct current (dc);
- have a voltage resolution of at least 0.1V;
- be able to display a peak voltage. For example, an electric fence pulse is only there for between 5 and 10 millionths of a second. Your normal meter may not record these spikes;
- be robust and easy to read and use;
- these meters must only be used by people that have been trained in stray voltage testing.

Some models are able to capture and store transient voltage spikes.

Figure 2. An example of a voltmeter.