Industry Bulletin

NZ Standard for the Safe Application of Electricity in the Meat Processing Industry

NZS 6116:2006

9 July 2009

The following issues have been identified by members of the original drafting committee and have been sent to Standards New Zealand for action but to date nothing has been done to update NZS 6116 and it is understood that Standards New Zealand have no plan at this time to do so.

The committee members involved would like to make users of the documents aware of the errors and updated information to allow the industry to be able the document to be adequate for its intended purpose.

Definition and Text clarification:

Class B definition relies on “pulse interval to period ratio” which is in fact the duty cycle. The word “interval” appearing with “period” should not be there and has caused the confusion. We would suggest adding “duty cycle” in brackets next to “pulse interval to period ratio” to confirm what is meant.

The calculation for r.m.s of a squarewave on page 13 has a similar use of pulse interval and could be simplified to Vrms=Vpeak*SQRT(Duty cycle).

Interpretation of Clause 3.7.5 of NZS 6116

Question:
Clause 3.7.5 relates to special requirements for conditioners and clause 3.7.5.1 relates to Class C conditioners only. Do clauses 3.7.5.2 and 3.7.5.3 also relate to Class C conditioners only or to Class B conditioners as well?

Answer:
Clauses 3.7.5.1 to 3.7.5.3 inclusive apply only to class C tunnel systems.

Editorial Errors that need to be addressed in Table 2:

P 33: **Item 14**. ***Reference:*** add, Clause 1.5 P33: **Item 17** ***Reference:*** add, Clause 3.3 P 33: **Item 18** ***Reference:*** add, Clause 2.1.1 P 33: **Item 22** ***Reference:*** add, AS 4024.1 P 33: **Item 23** ***Reference:*** add, AS 4024.1 P 33: **Item 25** ***Reference:*** add, Clause 3.7.5.3	P 34: **Item 27** ***Reference:*** Delete 3.7.5 add 3.2.3 P 34: **Item 28** ***Reference:*** Delete 3.7.5 add 3.2.3 P 34: **Item 29** ***Reference:*** Delete 3.7.5 add 3.2.3 P 34: **Item 30** ***Reference:*** Delete 3.7.5 add 3.2.6 P 34: **Item 32** ***Reference:*** Delete 1.5(e) add 1.6(e) P 34: **Item 35** ***Reference:*** Delete 1.5(g) add 1.6(g) P 34: **Item 36** ***Reference:*** Delete 1.5(e) add 1.6(e) P 34: **Item 37** ***Reference:*** Delete 1.5(e) add 1.6(e) P 34: **Item 38** ***Reference:*** Delete 1.5 add 1.6 P 34: **Item 39** ***Reference:*** Delete 1.6 add 1.6(f)

Method for determining the voltage a worker is exposed to at point of contact:

The direct application of electricity to carcasses has become an integral part of meat processing for many years. In addition to being used for pre-slaughter stunning, electrical applications include:

1. carcass immobilisation, to increase operator safety by controlling carcass movement
2. back stiffening, to avoid broken backs during hide pulling
3. carcass stimulation, to accelerate muscle pH decline and accelerate processing.

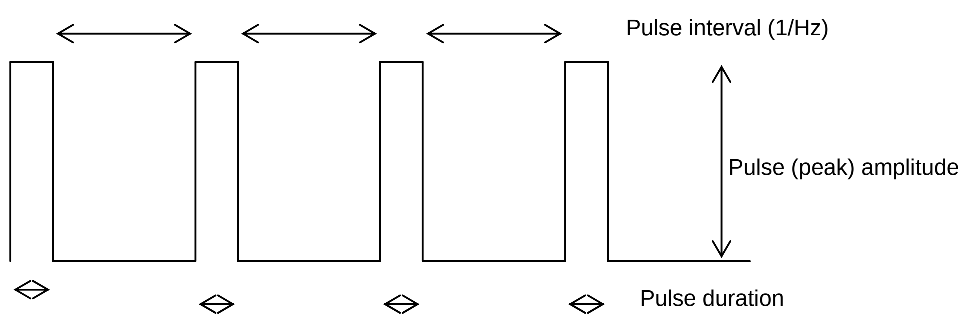
In many cases, the electrical immobilisation and/or stimulation of carcases is integrated into the processing chain and may require that dressing operations are performed while the current passes through the carcass. Even if processing is not taking place during the current application, there is often opportunity for physical contact between workers and the electrified carcass.

The new safety standard addresses the question of acceptable exposure to electrical currents during operations in meat processing facilities. The Standard (NZS6116:2006) introduces three levels of risk associated with electrical equipment:

1. Operator safe (Class A)
2. Touch safe but unsafe to work on (Class B)
3. Unsafe for contact under any circumstances (Class C)

The safety level of an electrical device depends on the risk associated with the specific waveform of the applied electrical voltage. In addition to the magnitude of the voltage, the Safety Standard also recognises that risks are affected by the nature of the of the electrical waveform: in particular, the risk assessment takes into consideration the frequency of the waveform and, where the waveform comprises isolated pulses, the duration of the individual pulses. Since most electrical devices used in meat processing are based on unipolar pulsed waveforms, the key safety considerations are the pulse interval (frequency) and pulse duration (Figure 1).

Figure 1: Electrical waveform components



The voltage used in calculating the safety requirement according to the formulae above is based on the ***voltage exposure at the point of contact with a worker***; it does not relate to the total voltage in the circuit. Therefore a safety evaluation needs appropriate methods to measure and monitor the voltages at likely points of contact, deliberate or accidental, with people. Also, a general appreciation of how the design and maintenance of the electrodes used to delivering the electrical current affects voltage exposures during contact with electrified carcasses will help to manage the risks.

Measuring the voltage exposures:

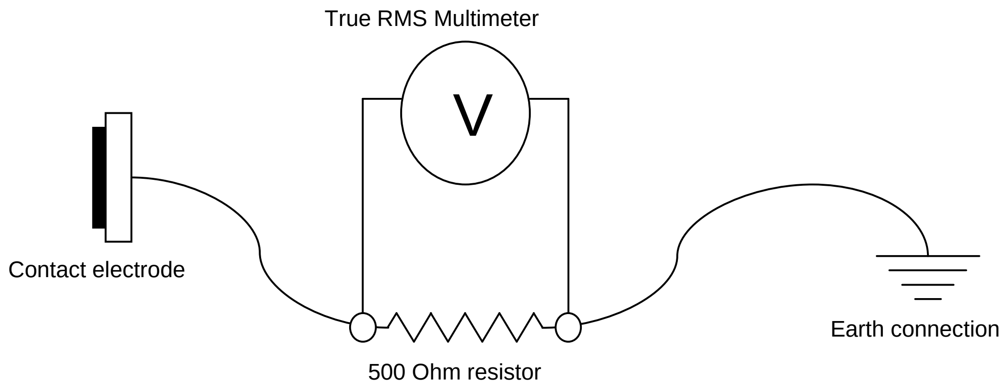
Designing a procedure to measure voltage exposure at the point of contact with an electrified carcass needs to take into account a number of factors:

1. *Electrical resistance of a person:* By convention, a person standing in boots completing an electrical circuit to earth through contact with an electrified carcass is considered to have an electrical resistance of 500 Ohms. A person's body can therefore be simulated by a 500 Ohm resistor
2. *Characteristics of the contact with the electrified carcass.* In addition to the resistance of the human body, there is also the resistance produced at the point of contact. This will depend on a number of factors, but the major ones will be the area of contact – the larger the area of contact, the less the contact resistance – and the pressure applied during contact – increasing pressure reduces contact resistance. The moisture level at the point of contact with a hide-on carcass is also a major variable and should be taken into account as part of identifying the 'worse case' scenario for an installation.

   To standardise the contact resistance, a contact electrode was constructed using a stainless steel plate with a contact surface area of 1000 mm^2 (10x10 cm) to represent a hand contact with a carcass. In addition, the contact pressure was standardised by spring loading the contact surface to produce a maximum pressure of 5 Kgf. A picture of the electrode used to monitor contact resistance is shown in Figure 3.

3. *Measuring system*. The voltage at the contact needs to be measured with a true RMS multimeter (we used a Fluke 189). Many conventional multimeters would not be appropriate because they are designed to measure the RMS of a 50 Hz sinusoidal waveform. More complex waveforms, such as pulsed DC waveforms, result in inaccurate readings.

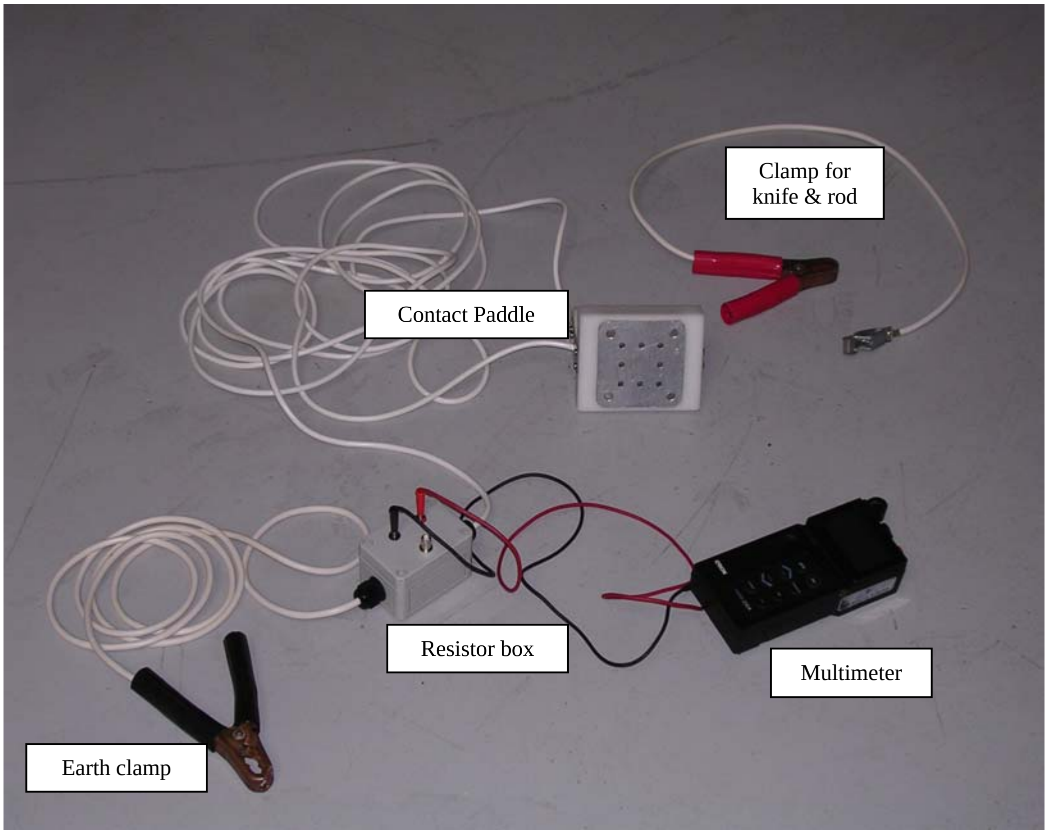
Figure 2: Circuit diagram of exposure voltage measurement.

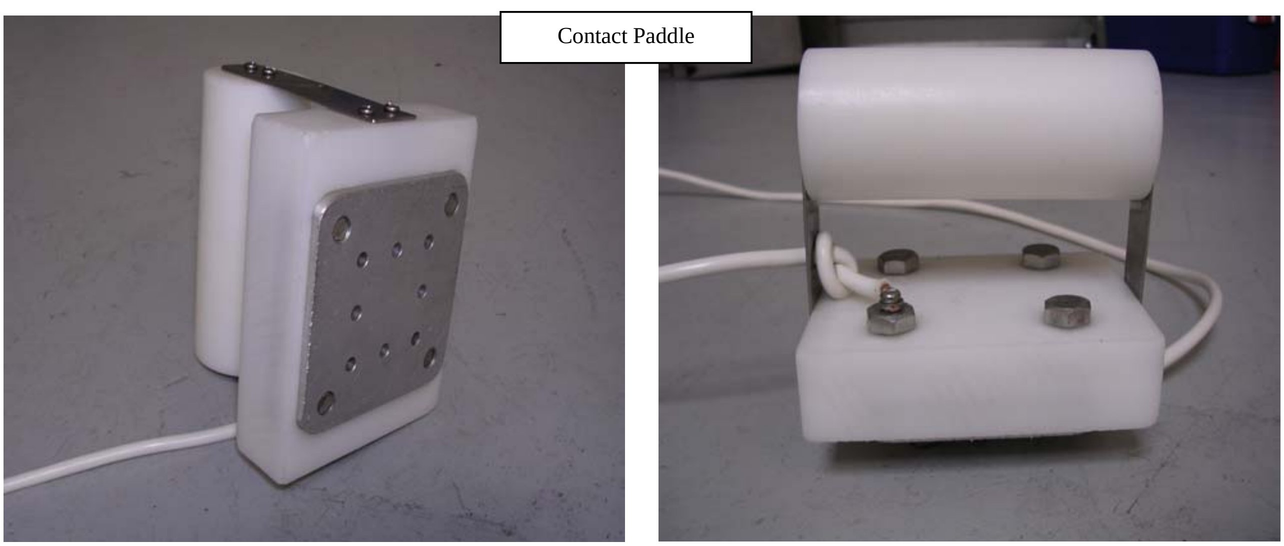


4. Measurement procedure. The complete circuit for the contact voltage measurement system is shown in Figure 2.The circuit is grounded at one end to local metalwork at earth potential. The contact electrode can then be applied to the carcass at positions within arm's reach. A reading of the voltage difference across the 500 Ohm resistance represents the exposure voltage.

   In those operations where dressing operations are carried out on the electrified carcass, metal tools such as knives or rodders can be applied directly to the surface of or inserted into a carcass as part of the normal operation. To test the voltage exposure under these circumstances, the contact electrode can be replaced with a clip which is attached directly to a metal surface of the tool during the operation. The exposure voltage is again measured as the voltage across the 500 Ohm resistor.

Figure 3. Equipment required to measure contact voltages at various points





Calculating the level of risk.

Class A: For continuously pulsed waveforms, the maximum permitted safe exposure voltage on electrified carcasses depends on two components of the waveform:
1. A maximum voltage of 6 Volts r.m.s. for a.c. or pulsed d.c. (or 15V ripple free d.c., which is not likely to apply to processing-related electrical devices)
and
2. I^2 (Amps r.m.s.) x ***pulse duration*** (secs) is less than 48×10^{-3}. The Amperage, in this equation, is calculated as measured exposure voltage / 500 Ohms

Class B*:* The maximum exposure voltage for a touch safe application, which does not permit working on the electrified carcass, is:
I^2 (Amps r.m.s.) ***x pulse duration*** (secs) is less than 48×10^{-3}.
or
pulse width to pulse interval is less than 1:8 for frequencies less than 1000Hz, or less than 1:3 for frequencies greater than 1000Hz

Class C*:* Unsafe for contact with carcasses
1. I^2 (Amps r.m.s.) ***x pulse duration*** (secs) is greater than 48×10^{-3}.
and/or
pulse width to pulse interval is greater than 1:8 for frequencies less than 1000Hz, or greater than 1:3 for frequencies greater than 1000Hz

Measured voltage exposures in existing commercial electrical installations.

At the present time, the majority of electrical applications to which workers are likely to be exposed are low voltage electroimobilisation systems. These are used in both beef and sheep dressing operations and typically involve unipolar pulses of 90 Volt amplitude, 10 msec duration and 70 msec pulse interval (15Hz).

Sheep immobilisation systems: All the systems evaluated used 4-point suspension, and the electrodes made contact through passive rubbing electrodes in contact with the fore and hind legs.

The main point of contact is the brisket area during the Y-cut, sticking and rodding operations. However, there is typically access to the back of the carcass and, therefore, contact can potentially be made to the hind legs. The chosen sites for testing were the brisket area and the rump area.

Potential exposure voltages were measured from 60 carcasses in four sheep plants and the results are shown in Table 1 below.

Table 1: Survey results from 4 sheep plants: exposure voltages to carcass contact during low voltage immobilisation.

	Plant 1	Plant 2	Plant 3	Plant 5
Average exposure voltage – brisket	2.20	0.61	1.88	0.29
Average exposure voltage –leg	3.79	0.65	1.96	0.21
Maximum exposure voltage	4.5	2.3	7.1	1.62
No carcasses exceeding maximum exposure voltage	0	0	1	0

Cattle immobilisation systems: Cattle can be immobilised on a landing cradle on which are mounted the immobilisation electrodes; or, where a bleeding conveyor is employed, they are immobilised using a mechanically operated electrode advanced to make contact with the rump. In both cases, the return electrode is either the metal work of the cradle/conveyor, or a separate, electrically isolated return electrode.

The main points of contact are the neck and rib areas during the sticking and rodding operations. In one plant, shackling took place during electrification of the carcass and a measurement was made on the rump

Table 2: Survey results from 4 beef plants: carcass exposure voltages to carcass contact during low voltage immobiliser.

	Plant 1	Plant 2	Plant 3	Plant 4
Average exposure voltage – brisket	2.42	2.11	3.02	3.93
Average exposure voltage –ribs	3.79	1.61	3.44	3.78
Average exposure voltage – rump			3.60	

Maximum exposure voltage	5.12	3.32	6.92	8.31
No carcasses exceeding maximum exposure voltage	0	0	2 (both rump)	1

Table 3: Survey results from 3 beef plants: exposure voltage from metallic contacts on knives and rodders during dressing operation.

	Plant 1	Plant 2	Plant 3
Average exposure voltage – knife blade	2.2	3.7	5.7
Average exposure voltage –rodder	3.79	1.61	3.44
Maximum exposure voltage	5.12	3.32	6.92 (both rump)
No carcasses exceeding maximum exposure voltage	0	0	1

Conclusion:

All the plants using the conventional low voltage systems (90 Volt peak amplitude, 10 msec pulses, 70 msec pulse intervals) largely complied with the requirements of the Safety Standard. The incidence of exposure voltages exceeding the 6 V a.c. was 1-2 carcasses per 60 carcasses measured, and the magnitude of the excess was small.

There were substantial differences in the exposure voltages between carcasses, and the different plants produced very different average results. The wetness of the surfaces contributed to part of this variation, but the electrical resistances between the electrodes and the carcass was also an important contribution. Understanding the relationship between the configuration of the electrodes and exposure voltage will need some better understanding but some general principles appear evident at this stage.

1. High electrical resistances at both electrodes produce low exposure voltages but also reduces the effectiveness of the stimulation.
2. An effective contact at the live electrode but poor earth electrode contact increases the exposure voltage
3. A proportion of the electrical current will flow though any metalwork in contact with the carcass. In sheep, the contact is between the hanger and the foot and, in cattle, the contact is with the landing table. The extent of insulation of the metal contacts from earth influences current leakage, which will affect both the exposure voltage and the voltage needed to produce effective immobilisation.

The use of metal tools in contact with electrified carcasses might be expected to increase the exposure voltage but their contribution was relatively small. Furthermore, the testing conditions were worse case scenarios that measured direct contact with the metalwork: in reality, both knives and rodders have insulated handles that will reduce the exposure voltages still further.

The measuring equipment provides a simple and effective procedure for testing the exposure voltages associated with contact with electrified carcasses. These procedures will provide the basis for assessing compliance with the new Electrical Safety Standard.