final report

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Prepared by: Paul Keane
Argus RealCold Pty Ltd

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Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Generation 2 MLA Meat Electronics Development (Commercialisation)

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Executive summary

The CPMS meat electronics (a suite of four separate technologies depending on application) has been a significant factor in improving the eating quality of Australian red meat and impact assessments have shown a good cost benefit ratio. Significant adoption of the CPMS meat electronics technologies by large volume beef and sheep meat processors has been achieved through on-site support by a commercialiser, Argus Realcold, for individual installations. The commercial uptake of the new electrical stimulation equipment for sheep plants has now reached 75% of total sheep process capacity and 70% of total beef process capacity in the top 56 largest meat processors.

It is important that the benefits of eating quality improvement contributed by the CPMS technologies flows on to medium and low volume beef and sheep processors.

The recently completed NZ standard NZS 6116 "Safe Application of Electricity in the Meat Industry" will eventually become an Australian Standard. This will require electronic equipment to have in-built limits in parameter selection to prevent the output energy exceeding the specified safety envelope.

A tendering process to identify suitable manufacturers has identified one particular company (HE Tech) who can not only produce the required electronics at the lowest cost, but have the skills to ensure electrical compliance (C Tick and CE) and design to safety specifications. This company also has a history of manufacturing electronics components for the red meat industry and is interested in being involved.

The MLA licensed commercialisers for Meat Electronics, Argus RealCold, will coordinate the electronics design and production as they will be the company who deal with HE Tech on an ongoing basis. The remaining part of the project involving on plant performance testing of prototypes will be jointly managed by RealCold and MLA personnel.

The purpose of this project was to ensure electrical compliance of meat electronics in Australia for the foreseeable future and minimise risk of eating quality failure due to forced removal of stimulation equipment from meat plants.

Contents

Background

- The CPMS meat electronics (a suite of four separate technologies depending on application) has been a significant factor in improving the eating quality of Australian red meat and impact assessments have shown a good cost benefit ratio.
- Significant adoption of the CPMS meat electronics technologies by large volume beef and sheep meat processors has been achieved through on-site support by a commercialiser, Argus Realcold, for individual installations. The commercial uptake of the new electrical stimulation equipment for sheep plants has now reached 75% of total sheep process capacity and 70% of total beef process capacity in the top 56 largest meat processors.
- It is important that the benefits of eating quality improvement contributed by the CPMS technologies flows on to medium and low volume beef and sheep processors.
- The cost of CPMS installation is significant and in the past has discouraged uptake by medium to low volumes processors. For example, for a $75,000 commercial sheep installation, the electronic cost is typically $25,000 and the mechanical cost is $50,000.
- Of the many medium to low volume users, a large interest has been exhibited by 30-40 of these processors wanting to go it alone on cheaper alternatives. This will be bad for the industry in the long run due to lack of managed installations and ongoing support and lack of compatibility with future technical developments.
- It is important now that we acknowledge this industry need by reducing overall installations costs. The cost of installation may be reduced with:
  - ii) a redesign to make the electronics cheaper, and
  - iii) by producing do it yourself kits with guidelines and remote support during and after installation. It is proposed to put a process in place to develop cheaper equipment which will be compliant with future electrical certification requirements.
- In addition, to the costs components of CPMS electronics, a future problem will emerge with lack of the electrical compliance. Current CMPS technologies have not been designed to meet the Australian electrical compliance certification because it was not a mass produced item. With the large uptake of electronics it is becoming increasingly difficult to argue that the electronics is not a standard industry component. In the future, it will be a requirement that all equipment of this type will need to have electrical certification (as a minimum, C Tick but probably CE as well).
- The recently completed NZ standard NZS 6116 "Safe Application of Electricity in the Meat Industry" will eventually become an Australian Standard. This will require electronic equipment to have in-built limits in parameter selection to prevent the output energy exceeding the specified safety envelope.
- A tendering process to identify suitable manufacturers has identified one particular company (HE Tech) who can not only produce the required electronics at the lowest cost, but have the skills to ensure electrical compliance (C Tick and CE) and design to safety specifications. This company also has a history of manufacturing electronics components for the red meat industry and is interested in being involved.
- The MLA licensed commercialisers for Meat Electronics, Argus RealCold, will coordinate the electronics design and production as they will be the company who deal with HE Tech on an ongoing basis. The remaining part of the project involving on plant performance testing of prototypes will be jointly managed by RealCold and MLA personnel.
- The purpose of this project was to ensure electrical compliance of meat electronics in Australia for the foreseeable future and minimise risk of eating quality failure due to forced removal of stimulation equipment from meat plants.

Project Outline

The following are the milestones:

Achievement Criteria	
1.	Factory Prototype designs completed and test for compliance (all 4 technologies).
2.	Production Prototypes completed and tested for compliance, ex factory (all 4 technologies).
3.	On-site installations of Production Prototypes completed (all 4 technologies).
4.	On-site testing of Production Prototypes confirm full compliance of equipment (all 4 technologies with MLA Gen 2 CPMS Meat Electronics Specification.

Project Objectives

The objectives of the project are:

- Produce Factory Prototype electronics designs of the four meat electronics technologies consistent with the MLA Generation 2 Meat electronics specification.
- Confirm C Tick and CE compliance of Factory Prototypes.
- Develop production prototype equipment of the four technologies and confirm compliance with C Tick, CE and NZS 6110.
- Confirm on-site (processing environment) operation of each of the four technologies. Demonstrate performances relating to eating quality and processing efficiency at least as good as Generation 1 Electronics and show complete compliance with all components of the MLA Generation 2 Meat Electronics Specification.

Experimental, Results & Discussion

Refer to the supporting documents for detailed papers for each of the milestones:

- Factory Prototype designs completed and test for compliance (all 4 technologies).
- Production Prototypes completed and tested for compliance, Ex-factory (all 4 technologies).
- On-site installations of Production Prototypes completed (all 4 technologies).
- On-site testing of Production Prototypes confirm full compliance of equipment (all 4 technologies with MLA Gen 2 CPMS Meat Electronics Specification.

Conclusion

Activity	Key Message
New Technology	No new technology only improved and a compliant version of what already exists.
Commercialisation / Dissemination Strategy	• Generation 2 meat electronics available on a commercial production basis at higher performance and less cost than current Generation 1 equipment. • Uptake of CPMS electronics by small and medium size meat processors accelerated. • Meat quality from small and medium processors enhanced.

Activity	Key Message
Final report	There will be no final report. All outcomes from this project will be delivered to the MLA Commercialiser for meat electronics (Realcold Milmech) for their use in advancing industry uptake of the technology.

Recommendations / Commercial

The commercial outcomes of the project :

- Factory Prototype electronics designs of the four meat electronics technologies consistent with the MLA Generation 2 Meat electronics specification.
- Confirmed C Tick and CE compliance of Factory Prototypes.
- Production prototype equipment of the four technologies developed and confirm compliance with C Tick, CE and NZS 6110.
- On-site (processing environment) operation of each of the four technologies validated. Demonstrate performances relating to eating quality and processing efficiency at least as good as Generation 1 Electronics and show complete compliance with all components of the MLA Generation 2 Meat Electronics Specification.

Appendix A – Commercial facts sheet

CONTROLLED DOSE ELECTRICAL STIMULATION AND IMMOBILISATION OVERVIEW

Realcold Milmech Pty Ltd has the commercialisation rights of controlled dose electrical stimulation and immobilisation, in conjunction with Meat & Livestock Australia and Applied Sorting.

Since the inception of this technology in December 2002, Realcold Milmech has successfully completed installations in both the beef and sheep industries resulting in providing consistent product quality to the end user.

The success of the roll-out of this technology has been enhanced by the endorsement of supermarket chains in that their product quality improvement is measurable.

V&V Walsh are a financial contributor to the original technology trials and have made a decision to install the mid-voltage electrical stimulation technology into their plant situated in Bunbury, Western Australia and commissioning is expected to be completed in February 2005.

PROCESS OVERVIEW

Ageing and tenderness of meat:

Muscles derive their energy from glycogen, which during exercise is broken down into energy and CO_2. In living muscles the pH remains just above 7.0, but can vary between 7.0 - 6.4 during exercise.

After death, the breakdown in glycogen leads to lactic acid because of the absence of oxygen. With blood flow having ceased the lactic acid cannot be removed. Thus the lactic acid gradually accumulates, and the muscle becomes more acidic with a lower pH.

Without any intervention either:

An ultimate pH = 5.5 is reached at which point the cell becomes too acidic for cellular enzymes to continue functioning and the residual glycogen remains in the muscles.

Or, all available glycogen in the cell is used up before the pH has fallen to 5.5. Without the fuel the cell ceases to function.

At these situations, the muscles are still and the animal is in rigor.

The MSA tenderness criteria determine that the glycogen decline/lactic acid formation needs to lower the pH to 6.0 with the muscle temperature between 35°C and 12°C, followed by standard ageing. This means that the time and temperature needs to be controlled to ensure that a pH = 6.0 is achieved within this "window of opportunity".

Outside of this "window of opportunity" two conditions can apply:

1. Animal's muscles pH reaches 6.0 at temperatures above 35°C and "heat shortening" occurs.
2. Animals' muscles pH does not reach 6.0 before the muscle temperature has fallen below 12°C and "cold shortening" occurs.

Hence there is a need to intervene and control the onset of rigor so that:

- Tender meat is produced without having to construct extensive facilities to allow the meat to age rapidly.
- Cold shortening/heat shortening and other problems are avoided.

The standard intervention system has been the application of electrical stimulation, post slaughter, as an electrical current applied to the carcass.

This application of electric current mimics the natural contract – relax signals in living muscles and this accelerates the breakdown of glycogen and accelerates natural ageing enzymes and the onset of rigor.

This intervention is important for:

the chilled meat trade to provide a consistent and correct level of tenderness for local trade. For export trade, the natural ageing rate is very slow at 0°. Hence, during transport it cannot be relied on to produce consistent and correct tenderness particularly if the initial processing time/temperature regime was not correct.

For the frozen meat trade, the natural ageing process is halted when the meat is frozen. Furthermore, if the meat is rapidly chilled and cold shortened this can interfere with the ageing enzymes. Thus the meat will be tough on thawing unless it has been correctly stimulated prior to freezing.

In an overall situation it has been possible to achieve accelerated ageing within normal processing sequence using electrical stimulation. However it has not been possible to guarantee that each individual animal has been correctly stimulated to achieve the optimum tenderness.

This is because the existing systems:

- Do not control the dosage of electricity each carcass receives.
- Do not have the facility for varying and adjusting the waveform.
- Do not measure the individual animal resistance to be able to control the stimulation.

The MLA systems developed have overcome these problems, with controlled dose technology.

The system controls the dosage each animal receives by:

- Segmenting the system so that each carcass is monitored individually.
- The feed back from monitoring allows the dosage and timing to be adjusted for that carcass.

The waveform is adjustable in such a manner as to allow use of narrow pulse widths, which allows use of higher currents that still remain safe. This allows more energy input to the carcass.

The system measures the carcasses resistance and this measure gives the feedback enabling control of the dosage. This is done by applying small test pulses to each carcass.

There are differing forms of electrical energy inputs available which have differing applications such as mid-voltage stimulation, low-voltage stimulation, high frequency immobilisation, low frequency immobilisation and electronic back stiffening - all having an effect on product quality.

With electrical stimulation the rate of pH fall can now be controlled with the rate being affected by:

- How long after slaughter the stimulation is applied.
- The magnitude of the applied current and duration of application.
- The waveform of the applied current.
- Other electrical inputs to each animal, (eg. "Stimulation" is the total effect of all electrical inputs – not just the stimulation system alone).

High frequency immobilisation:

This system utilises a high frequency waveform, which activates the nervous system and renders the animal in a relaxed, limp state. The advantage of this system is that there is no effect on ecchymosis or the tearing of the muscle structure, (as caused by the existing immobilisers in use today), with no adverse effect on the rate of pH decline, (major cause effecting meat quality), which has the added advantage when processing grain fed animals.

Appendix B – Commercial publication

processing

Taking the guesswork out of electrical stimulation

New technology jointly developed by Realcold Milmech in conjunction with Applied Sorting Technologies and Meat and Livestock Australia (MLA) has taken the guesswork out of applying electrical stimulation to cattle and sheep carcasses. The system is already operating in a number of sheep and beef plants throughout Australia.

Electrical stimulation accelerates pH decline, the onset of rigor mortis and the natural ageing process. This allows meat to reach an acceptable eating quality in a significantly shorter period of time and can alleviate problems caused by the faster chilling of carcasses. The challenge for processors is to match the level of electrical stimulation (ES) to the rate of chilling and the time the meat is scheduled to reach the consumer.

Muscles derive their energy from glycogen, which during exercise is broken down as a fuel producing lactic acid. In living muscles the pH remains just above 7.0 but can vary between 7 and 6.4 during exercise.

After death, the breakdown in glycogen to lactic acid continues, but with blood flow having ceased the lactic acid cannot be removed. Thus the lactic acid gradually accumulates and the muscles become more acidic with a lower pH.

Without any intervention either:

- An ultimate pH of 5.5 is reached — at which point the cell becomes too acidic for the cellular enzymes to continue functioning and the residual glycogen remains in the muscles; or
- All available glycogen in the cell is used up before the pH has fallen to 5.5. Without the fuel the cell ceases to function.

At these situations, the muscles are still and the animal is in rigor.

The MSA tenderness criteria determine that the glycogen decline/lactic acid formation needs to lower the pH to 6.0 with the muscle temperature between 35°C and 12°C, followed by standard ageing. This means that the time and temperature needs be controlled to ensure that a pH of 6.0 is achieved within this 'window of opportunity'.

For any given chilling rate, too much ES results in too rapid a pH decline. If pH 6 is achieved at a temperature above 350°C 'heat shortening' occurs and the natural ageing enzymes are destroyed. With inadequate ES where the carcass does not reach pH 6 before the temperature falls below 120°C, 'cold shortening' occurs and ageing of the meat is delayed.

The standard intervention system has been the application of electrical stimulation, post slaughter, as an electrical current applied to the carcass. This application of electric current mimics the natural 'contract/relax' signals in living muscles and this accelerates the breakdown of glycogen and serves to hasten the onset of rigor.

This intervention is important for:

- The chilled meat trade to provide a consistent and correct level of tenderness for local trade. For export trade, the natural ageing rate is very slow at 0°. Hence again during transport it cannot be relied on to produce consistent and correct tenderness, particularly if the initial processing time/temperature regime was not correct.
- For the frozen meat trade, the natural ageing process is halted when the meat is frozen. Further, if the meat is rapidly chilled and cold shortened this can interfere with the ageing enzymes. Thus the meat will be tough on thawing unless it has been correctly stimulated prior to freezing.

The effective level of ES is a function of the carcass type and the total electrical load applied to the carcass during the slaughter process. Electrical inputs can come from immobilisers, bleeders, back stiffeners and stimulators with the effect of each depending on the voltage, its duration and the waveform.

The new system accounts for the total electric load (including immobilisation and back stiffeners etc) and can be adjusted on the basis of the ideal electrical inputs for particular carcass types. Its main feature is its use of test pulses to determine the resistance of a carcass and the use of this information to apply the same, precise electrical dose control to all carcasses. The optimal pH decline for any given chilling rate can then be obtained to maximise the benefits of rapid ageing.

Realcold Milmech Pty Ltd
www.realcoldmilmech.com