final report

Development and implementation of a capability program for management and potential further enhancement of electrical intervention technologies

Stage 1 – Scoping and feasibility study

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Abstract

An electrical audit and survey questionnaire were conducted at 14 sites ranging from small to large producers of sheep and beef to gauge the compliance of equipment and establish their requirements for developing their capabilities. It was found that two sites had no issues with their equipment, 5 sites had equipment needing repair and 7 sites needed advice for better operation of their current equipment or a source of effective equipment. All sites gauged the efficacy of the electrical intervention equipment on the carcase response with variable knowledge of the correct physical response and only one site had the ability to measure the electrical output. Sites want equipment that is easy to use to measure the electrical output with hands on, in house training of the measurement equipment. Many sites wanted the equipment to fill a monitoring role and integrate with the site control systems.

It is recommended that a broad capability program be developed to provide the industry with the appropriate measurement equipment and develop the skills and capability amongst the industry by way of auditing procedures and standard operating procedures. Part of this would be to perform electrical audits, independent pH declines and deliver the questionnaire to all Australian meat producers to get a true bench mark of the industry compliance of their equipment and pH declines. The broad capability program would address the New Zealand Standard 6116:2006 being a joint Australian standard, the development of measurement equipment and hands on / onsite training to enable internal auditing of the equipment.

Executive summary

Over the past ten years red meat processors have adopted electrical technologies for immobilisation, bleeding, stimulation, and back stiffening; to improve eating quality and personnel safety. These technologies have had a significant impact in terms of OH&S, eating quality and processing efficiency. However, there is evidence that some of the commissioned electrical intervention equipment is not adequately maintained and/or is not working optimally (e.g. over or under electrical stimulation). As meat electronics equipment ages the problems associated with poor maintenance are liable to become exacerbated putting at risk the gains made in OH&S, eating quality and processing efficiency.

Pearce *et al.* (2010) demonstrated that four abattoirs which process a significant proportion of Australian lamb and sheep meat, produced carcasses with poor pH – temperature compliance because of ineffective or inadequate electrical stimulation units. The fifth abattoir in the study produced carcasses with good pH – temperature compliance because of frequent and extensive pH testing due to research projects conducted at the plant.

A third party independent review of several processors funded by MLA identified that capability of the industry in general needs to be addressed to enable processor's to measure and maintain compliance of equipment (Bloxsom, 2012).

The purpose of this program is to develop the appropriate skills and capability amongst the industry with all plants owning and operating any of the suites of electrical intervention technologies. A broad capability program is proposed as follows:

Stage 1: Perform a scope and risk assessment of targeted companies (maximum of 15)

Stage 2: Develop equipment, training packages and SOP for non-compliance

Stage 3: Testing of pilot package (selected plants) and evaluation of tools for compliance testing

Stage 4: Implementation of package to wider industry

Stage 5: Evaluate success of rollout of training package(s). Report on capabilities.

This project addressed stage 1; where an assessment of industry compliance to pH verses temperature decline was made and electrical intervention equipment was audited at 14 commercial processors. During the audit the processors were also surveyed as to their monitoring and reporting practice of the electrical intervention equipment and their requirements to be able to monitor the equipment.

The main regulation governing the installation of electrical equipment is AS/NZS 3000:2007 – Electrical Installations; known as the Australian/New Zealand Wiring Rules. This standard regulates the safe manufacture and installation of an appliance and has no requirement for regular inspection other than maintaining the equipment in a safe operating condition. Two reports produced for the MLA by The University of New South Wales; Grantham's Unisearch J054616 – Interpretation of Australian / New Zealand Standards AS/NZS 60479.2:2002 and Blackburn's further analysis of Grantham's report and other published data, both establish the safety of the output waveform and methodology for calculating the risk, but, neither establish a requirement for testing the equipment's output. However, the Blackburn and Grantham reports were used in NZS 6116:2006 – Safe Application of Electricity in the Meat Processing Industry and although not an Australian Standard would be considered as best practice given the

absence of an Australian Standard covering the specific waveforms used in the electrical intervention equipment. It would be deemed that the majority of Australian processing facilities would not be meeting an established best practice due to few having the ability to audit the equipment and don't have it audited by an external party. As such processors could be exposing themselves to legal action should an investigation occur due to an incident with an electrical intervention technology.

A review of 15 plants with existing electrical intervention technologies across small and large, beef and lamb processing operations showed that visual carcase response and measurements of carcase pH is industry practice to monitoring the correct operation of the range of electrical input equipment. The majority of plants would like formal training in "what is a correct response" and evidence suggests this knowledge is lacking throughout the industry including on site personnel, Department of Primary Industries and Meat Standards Australia. Only one processor surveyed had test equipment suitable to test the intervention technology and most sites did not have personnel with current skills to use such equipment. Processors on site test capabilities are limited to the electrical supply to the equipment and the field wiring. Processors would like a means of measuring the output of equipment with the majority wanting this to be in real time and recorded automatically as well as measurement equipment to quantify the output waveform.

Audits of the equipment found;

- 2 plants had no issues
- 5 plants had equipment needing repair
- 7 plants needed advice for better operation of their current equipment or a source of effective equipment.

These findings were such that the majority of processing facilities had equipment issues that should have been influencing their ability to meet the requirements for producing product of acceptable eating quality.

A key finding of the survey was that the electrical intervention technology is process critical to maintaining personnel safety and processing compliance; however, very few maintained spare parts on site. With the majority of the surveyed processing facilities utilising the Applied Sorting Technologies (AST) equipment there was grave concern that there are no longer spare parts available or long term scope for future service of the equipment.

StimTech met with AST and determined the feasibility of technology transfer to enable an external entity to produce spare parts and service the range of equipment. However, this would require the establishment of a project to facilitate the culmination of the technology and knowledge to be transferable. However, the subsequent purchase of AST by Scott Automation has verbally suggested that they will in the future have spare parts available.

The survey established that further to the requirement of measuring equipment that sites required formalisation of the requirement and a methodology to monitor the equipment. The training in such a program was seen as best delivered in house, on site and hands on by a third party with integral technical knowledge of the equipment and its use in processing. Although hands on training was seen as important it was also expressed that reference material in both written and visual form would be retained on site for future reference and in house training of personnel operating in the vicinity of the equipment. The written manual and visual reference material was seen as integral to maintaining the knowledge base on site and to facilitating future instruction of personnel.

Processors recognise the advantage in measuring the output of the equipment, but, also know that the commercially available means of doing so is not suitable for use by QA and foreman. Sites require a piece of equipment able to measure the output parameters of the electrical input equipment. Three levels of sophistication were commonly discussed each with a pass / fail for each of the parameters; portable unit applied to the electrodes, on line unit with read out and an online unit that interfaces with the site computer system.

This project has established the need of a program outlined as “A broad capability program” to develop the tools and skills required for the Australian Meat Industry to measure and monitor the electrical intervention technology.

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1 Background

1.1 Electrical Intervention Technologies

MLA has developed a suite of electrical interventions since 2002 with wide adoption. Commercial applications using electrical technologies include immobilisation, electronic bleeding, back stiffening and electrical stimulation.

The proven benefits of the electrical intervention technologies are; operator safety, improved quality and / or eating quality. A key attribute of the technology has been in the development of constant current narrow pulses which provide additional operator safety over and above competitive technologies such as the constant voltage systems developed by New Zealand operators.

There is evidence that commissioned electrical intervention equipment is not working optimally, and in some cases is actually impacting adversely to quality by over or under stimulation. A CRC survey was conducted on five sheep meat operations in 2007 and surprisingly identified that only one plant's electrical technologies was considered to be operating effectively.

There has been an apparent unwillingness for processors to pay for an annual contract service for auditing and maintenance of Meat Electronics equipment. This is evidenced when recently StimTech was contracted to audit a plant which presented the opportunity to visit four other plants in close proximity. With the cost of travel and time already covered, StimTech offered a cost effective option to audit and service each of the 4 plants for a nominal $600-$700 per plant; remarkably only one of the four plants signed up for the service.

A third party independent review of current electrical technologies and impact on quality and / or eating quality (Bloxsom, 2012) identified that there was a major apparent deficiency in capability and ability for company operatives to audit and evaluate, service and maintain electrical intervention equipment.

In addition, there are numerous experiences where a lack of industry capability contributed to major disruptions and down times because technologies were not able to be accessed, site personnel were unable to isolate the source of the problem and rectify it quickly. There is no greater example of this with existing facilitated adoption R&D projects co-funded in a collaborative R&D project with two mid-voltage electrical stimulation installations. Major delays of several months were experienced while intermittent issues with equipment were identified and rectified. The major source of the problem where lengthy down times are experienced are caused by processors not identifying "champions" with the appropriate skill sets to check, service and maintain the equipment nor providing the required test equipment or skills to utilise it. It is also acknowledged that a range of operatives (i.e. QA or MSA grader) and skills may be required to check, routinely check and service and maintain equipment (i.e. engineers, plant electricians, etc.).

The majority of electrical intervention technology used in the Australian meat processing industry has been manufactured by Applied Sorting Technologies (AST). AST's decision to no longer manufacture the suite of electrical intervention equipment has also seen stocks of spare parts depleted to extremely limited parts with the common units no longer having spare power output boards or transformers. It is likely by the end of 2014 that AST will also no longer have personnel to service the equipment. What this means is, should a plant have an equipment failure, they will need to purchase a replacement unit. The Australian manufactured equipment has a lead time of approximately eight to ten weeks. Processors cannot operate without the equipment for this period and as such they are purchasing equipment from overseas.

There are no regulatory constraints which directly address the output waveform of the electrical intervention technologies. AS/NZS 3000:2007 – Electrical Installations; known as the Australian/New Zealand Wiring Rules, regulates the safe manufacture and installation of an appliance and has no requirement for regular inspection other than maintaining the equipment in a safe operating condition. The only regulation directly addressing the use of the electrical intervention technology is the New Zealand Standard; NZS 6116:2006 – Safe Application of Electricity in the Meat Processing Industry. This standard was written with consideration to the Australia and New Zealand technologies, adopting work conducted by senior electrical engineers at Sydney University. The outcome was a lawful regulation of New Zealand, not adopted by Australia. Occupational Health and Safety (OH&S) requirements refer to “best practice” in the absence of specific regulations.

1.2 Electrical Intervention Technologies Capability Development

Over the past ten years red meat processors have adopted electrical technologies for immobilisation, bleeding, stimulation and back stiffening; to improve eating quality and personnel safety. These technologies have had a significant impact in terms of OH&S, eating quality and processing efficiency. However, there is evidence that some of the commissioned electrical intervention equipment is not adequately maintained and / or is not working optimally (e.g. poor immobilisation, ineffective back stiffening, over or under electrical stimulation). As meat electronics equipment ages the problems associated with poor maintenance are liable to become exacerbated putting at risk the gains made in OH&S, eating quality and processing efficiency.

The industry is not motivated and don’t have the capability or capacity to maintain the equipment for two reasons:

1. Lack of a value proposition for meat processors. This is evident as industry players are not willing to invest in as little as $1,500 in service contracts offered by StimTech and the conclusion drawn is that without a change in the value proposition the service business is not sustainable.

2. Lack of capability “in house” to service the electrical intervention technologies - which will be addressed by this proposal.

A third party independent review of several processors funded by MLA identified that the capability of the industry in general needs to be addressed to enable processor’s to measure and maintain compliance of equipment (Bloxsom, 2012).

The purpose of this program is to develop the appropriate skills and capability amongst the industry with all plants owning and operating any of the suites of electrical intervention technologies. A broad capability program is proposed as follows:

Stage 1: Engage regulators and do a scope and risk assessment of targeted companies (max 15 companies and/or regulatory bodies)

Stage 2: Develop equipment, training packages and SOP for non-compliance

Stage 3: Testing of pilot package (selected plants) and evaluation of tools for compliance testing (if required)

Stage 4: Implementation of the package to the wider industry

Stage 5: Evaluate success of rollout of training package(s) and report on capabilities.

In this initial project (stage 1) following a survey of processing plants and an assessment of their electrical intervention technologies and pH decline data, the extent of the problem will be identified, the scope and cause of the non-compliance of electrical intervention technologies highlighted and what opportunities exist to rectify the problem cost-effectively (preferably internally). The scope of this initial stage would be to undertake a review of selected plants (up to fifteen plants) with existing electrical intervention technologies across large and small, beef and lamb processing operations.

The current project proposes to evaluate options for the requirement to develop and implement a skills and capability program to be rolled out to all plants with electrical intervention technologies to assist with plant self-assessment and tools for testing and monitoring electrical intervention technology inputs to carcases. The outcome of this initial phase is to determine the scope and format of a learning and development package to be implemented and disseminated to processors, who are the target for the package and what additional processes and / or technologies might need to be developed to support internal company assessment of electrical intervention technologies.

2 Project objectives

The objectives of the project are to evaluate regulatory and company requirements for on-site capability surrounding electrical intervention technologies (i.e. phase one of the broader program).

The purpose of this initial phase is to address

i) minimum regulatory requirements in terms of operator safety

ii) processor requirements in terms of a capability package (i.e. testing equipment, checkers and capability to conduct their own evaluations)

The outcome of phase one will be:

- Company and regulatory information that will inform the broader capability program
- Mechanism on how it should be rolled out (instruction manual, training package, possible development of test equipment prototypes)
- What companies need their capabilities developed
- What companies to develop capability e.g. MSA, processors, MINTRAC etc.
- What additional technologies may need to be developed (e.g. sensors) to support company diagnostics
- Development of a diagnostic / testing device for plant operatives
- Capability building package and dissemination
- Development of key industry messages to support an industry contract service survey

A final report and presentation to MLA on recommendations for

i) development of a capability program

ii) suggested skills & capability materials

iii) provision and adoption of the skills and capability package to the wider industry

3 Methodology - Scope

3.1 Project activities

The project was developed to complete the following activities.

Stages	Activities
1	Develop scope / options for developing capability module (s) and a meeting & data collection schedule to support the approach. Preliminary discussions with MLA, targeted companies and regulatory bodies to develop the approach and timetable. Milestone 1: Report to MLA on the scope and options and a corresponding meeting schedule.
2	Review and desktop audit of regulations and specifications for electrical input equipment. Qualify regulatory & OH&S requirements and specifications by i) facilitated discussions with Regulatory authority(s), ii) review of current electrical regulations. Milestone 2: Brief update to MLA on regulatory and safety requirements.
3	Collecting new data – Review of MSA pH decline data and independent studies of compliance of technology to meet standards. Including significant input to an update to MSA Management Team meeting. Milestone 3: Brief update to MLA on quality and/or eating quality compliance data from MSA records.
4	Through facilitated company meetings and discussions, determine processor requirements for i) routine testing, ii) capability & training needs iii) dissemination, and iv) OHS incidences. Milestone 4: Brief summary provided to MLA on company requirements for proposed capability program.

5	Report to MLA on recommendations for a broader capability program to deliver the required skills and capability of plant operatives to support the full suite of electrical interventions (developed through previous MLA & Industry funding). Milestone 5: Detailed final report and presentation to MLA and / or MSA SMT meeting in early 2014 detailing site equipment compliance and recommendations on i) routine testing requirements, ii) capability of training organisations and training materials, and iii) dissemination of the capability package to wider industry. Significant contribution into the Lamb Supply Chain Meeting with recommendations on a capability program for the sheep meat industry. GO / NO GO point for the "broader program", following third party audits on the outcomes of phase 1. Support from the MLA on the outcomes of phase 1 to result in the development of a capability program to complete phases 2 - 5.

3.2 Regulation Review

A review of regulations, standards and previous investigations; regarding the range of electrical intervention technologies; was undertaken specifically with respect to the testing requirements for electrical safety and the Occupational Health and Safety aspects of the equipment. Site electrical staffs citation of AS/NZS 3000:2007 Electrical installations as their governing standard established this as the primary document for review along with IEC 60364 Electrical Installations for Buildings.

A review of documentation regarding the output waveforms safety was conducted with reference to previous reports for the MLA by Associate Professor Colin Grantham which was later critiqued by Professor Trevor Blackburn with reference to data in "Electrical Stimulation and Electropathology" by Patrick J Reilly. These reports were cross referenced against cited publications of AS/NZS 60479.2 Effects of current on humans and livestock Part 2: Special Aspects; and AS/NZS 60335.2.76:2003 Household and similar electrical appliances – Safety – Particular requirements – Electric fence energisers.

3.3 pH Decline Compliance Review

A review of available pH decline data was undertaken to establish the rate of industry compliance to pH verses temperature decline. The MSA data base of processor pH decline data was not analysed due to the data contained in the database being "Commercial in Confidence". Discussion was undertaken with MSA managers, MSA Trade Development Officers, Department of Primary Industry Trade Development Officers and University Researchers regarding their experience and a literature review of research publications.

3.4 Plant Electrical Input Audit and Survey

The electrical input audit and survey was conducted at the selected sites with a project team consisting of StimTech, MSA and / or MLA technical managers considered on a plant by plant basis. The plants selected covered a range of large and small beef and sheep producers to make an assessment of the condition and operation of their equipment, whether it is fit for purpose and determine if the minimum safety requirements (as prescribed by the MLA) are being met.

Applied Sorting Technologies was visited to determine the feasibility of developing a program for future service of the Applied Sorting Technologies range of electrical intervention technologies.

An interview process amongst plant operatives such as management, operations managers, engineers and electricians and QA and/or MSA graders involved directly or possibly indirectly in overseeing the electrical intervention technologies operating. The interview process was focused on key plant operatives to understand what and how a training packaging might be customised and delivered to the plant for maximum chance of uptake of the training package. During the plant interview process, it will also be determined what capability currently exists in plants to undertake assessment of equipment or in fact if new cost-effective diagnostic approaches or technologies need to be developed as part of the next phase.

An initial interview questionnaire was delivered to one sheep and one beef site with the outcome reviewed by a technical committee to ensure the questions, responses and delivery resulted in appropriate information to assess the requirements of a training program. The final questionnaire was then used at the remaining sites visited.

The sites visited and schedule is presented below;

	Site	Species	Date
Trip 1	Plant 1	Beef	21 January 2014
Trip 2	Plant 2	Sheep	22 January 2014
Trip 3	Plant 3	Sheep	10 February 2014
	Plant 4	Sheep	11 February 2014
	Plant 5	Sheep	12 February 2014
	Plant 6	Beef	13 February 2014
Trip 4	Plant 7	Beef	17 February 2014
	Plant 8	Beef	17 February 2014
	Plant 9	Sheep	18 February 2014
	Plant 10	Beef	18 February 2014
	Plant 11	Beef	19 February 2014
Trip 5	Applied Sorting Technologies	Manufacturer	25 February 2014
	Plant 12	Sheep / Beef	26 February 2014
	Plant 13	Sheep	26 February 2014
	Plant 14	Sheep / Beef	27 February 2014

Species	Number of sites visited
Sheep	6
Beef	6
Sheep / Beef	2
Manufacturer	1
Total	15

Table 1: Interview Questionnaire

Focus Areas	Questions	Desired outcome
i) Compliance	a) Are you aware of any compliance issues or equipment failure in the past?	This will identify the extent of the problem, scope and cause of the non-compliances of Meat electronics technologies, and what currently happens to rectify the problem.
	b) If so, how was the non-compliance or failure detected?	
	c) What action have you taken to fix equipment or compliance issues in the past?	
	d) Who is responsible for ensuring safe operation of ES equipment?	
ii) Monitoring	a) Who in your company is responsible for monitoring ES equipment?	This will determine who to target for the training package and the scope of the content.
	b) How do you monitor the performance of the equipment?	
	c) Do you keep records?	
iii) Training package	a) What format of training package would assist? i.e. Training manual, delivered through MSA training and compliance services, provided by a third party? On-site training? Centrally located training?	This will determine the scope and format of a learning and development package to be implemented and disseminated to plants.
	b) Who in your company should be involved?	
	c) Will training benefit your company?	
iv) Capability	a) Who monitors and measures equipment operations day to day?	This will identify the current skills

	b) What are you able to measure, monitor and service yourselves (up to what point based on your capability?)	and capability of plant personnel who monitor/service electrical technologies inputs.
	c) If measuring equipment was purchased who on site would use it QA, Electrician, Production manager?	
	d) Would measuring equipment need to be basic or technical?	
v) Service and delivery package	a) What service and delivery package (over and above what a company can deliver) do you require?	This will assist identify what additional technologies may need to be developed (e.g. sensor) to support company diagnostics; and if a commercial support service could be viable.

The audit of the electrical input equipment involved the examination of the electrodes, electrode support structure, safety signage, safety switches, operating light and wiring. Observations were made of the operation of the equipment and the carcase response to the activation of the current output. Measurements were conducted of the stimulation waveform current using a Fluke 43B Power Quality Analyser and a Lem Heme PR30 Current Probe either directly with carcases on the electrodes or using a 150Ω 100W power resistor as a dummy load.

Photo 1: Fluke 43B Power Quality Analyser, Lem Heme PR30 Current Clamp and dummy load.

Photo 2: Current measurements being undertaken.

4 Results and discussion

4.1 Review of regulations

The main regulation governing the installation of electrical equipment is AS/NZS 3000:2007 – Electrical Installations; known as the Australian / New Zealand Wiring Rules along with IEC 60364 Electrical Installations for Buildings. These standards regulate the safe manufacture and installation of an appliance, but, have no requirement for regular inspection other than "maintaining the equipment in a safe operating condition".

Two reports produced for the MLA by The University of New South Wales; Grantham's Unisearch J054616 – Interpretation of Australian / New Zealand Standards AS/NZS 60479.2:2002 and Blackburn's critique of Grantham's report with its inclusion of analysis of other published data, both establish the safety of the output waveform and methodology for calculating the risk, but, neither establish a requirement for testing the equipment's output.

However, the Blackburn and Grantham reports were used in NZS 6116:2006 – Safe Application of Electricity in the Meat Processing Industry and although not an Australian Standard would be considered as best practice given the absence of an Australian Standard covering the specific waveforms used in the electrical intervention equipment. NZS6116:2006 states *"All equipment shall be maintained in a manner that preserves the integrity of its original design, ensuring electrical safety and meeting the requirements of this standard"*.

A major part of the NZS6116:2006 is establishing routine inspection of the equipment and that the degree of protection is established by measurement of the waveform at the point of possible contact. As such it would be deemed that the majority of Australian processing facilities would not be meeting an established best practice due to few having the ability to audit the equipment or seek to have it audited by an external party. As such processors could be exposing themselves to legal action should an investigation be instigated due to an incident occurring.

Under NZS6116:2006 the electrodes can be exposed due to the parameters of the waveform. It would follow from this if the parameters of the waveform are unverified then the electrodes should not be exposed.

4.2 Review of available pH decline data

Commercial in Confidence

4.3 Equipment audit

Table 2 provides a summary of the audit results; however, all equipment audit reports are available as a separate file on request.

Audits of the equipment found;

- 2 plants had no issues
- 5 plants had equipment needing repair
- 7 plants needed advice for better operation of their current equipment or a source of effective equipment.

Table 2: Electrical Inputs Equipment Audit Summary

Company	Species	Electrical Input				Non-compliance Issues
		HFI	LVES	BS	MVES	
Plant A	Beef	✓	✓	✓		Using a Pulsed Energy Immobiliser (150Hz). Inconsistent electrode contact with 3 pad system. No emergency stop or readily visible operating light on HFI.
Plant B	Sheep				✓	Two failed graphical user interfaces. Water ingress in 2nd stimulator and remote control.
Plant C	Sheep	✓	✓		✓	RHS HFI operate FET bypassed – overheated FET. RHS HFI output failed. Blunt HFI electrodes – poor contact. Worn MVES stainless electrodes and fractured insulators – contamination issue.
Plant D	Sheep		✓			Site devised lights to indicate individual module operation do not show a failed module.
Plant E	Sheep/Beef				✓	Using constant voltage HETech Tenderpulse on beef. No sheep stimulation operating. Will be using constant voltage system.
Plant F	Beef	✓	✓	✓		Constant voltage stimulator used to immobilise.

Plant G	Beef	✓	✓	✓		High resistance 0V HFI contact to rotating platform inhibiting meeting selected current. HFI operate light is always illuminated regardless of current being applied to carcase. Recommend mechanical fastening LVES electrodes to support structure.
Plant H	Beef		✓	✓		Multiple carcases on LVES for proportion of stimulation time – variable stimulation rate. 1st BS is always indicating it is active – possible fault or "leaky" wiring.
Plant I	Sheep				✓	Broken wire to one electrode on first set of electrodes. Failed output module on second set of electrodes.
Plant J	Beef	✓	✓	✓		
Plant K	Beef	✓	✓	✓		Reposition HFI electrodes or install a crossover system to a manually applied probe. Poor stimulation waveform and bad electrode contact.
Plant L	Sheep/Beef	✓	✓		✓	Inconsistent programming of MVES modules. One failed MVES module. Stepping chain not indexing correctly with carcases spanning two electrodes. LVES constant voltage stimulator.
Plant M	Sheep				✓	

Plant N	Sheep/Beef	✓	✓	✓	✓	Broken remote control enclosure – water ingress, Failed LCD display. Failed serial interface.

HFI – High Frequency Immobiliser

BS – Back Stiffener

LVES – Low Voltage Electronic Stimulator

MVES Mid Voltage Electronic Stimulator

These findings were such that the majority of processing facilities had equipment issues that should have been influencing their ability to meet the requirements for producing product of acceptable eating quality.

Five sites had equipment that is in need of repair. In the worst case one site was operating at three quarters of its effective stimulation. Two of the sites did not know that the equipment was not operating correctly. The “system” fails by sites not accurately knowing what their equipment is operating at and what the correct response should be. MSA TDO’s and DPI Officers during the site visits also demonstrated that although they were knowledgeable of electrical inputs that recognising correct carcase response wasn’t always straight forward.

A major issue with the majority of sites is the lack of spare parts held on site and the unavailability of spare parts for the Applied Sorting Technologies manufactured equipment.

Photo’s 1 through 5 below show some of the failures and issues seen during the electrical equipment audits.

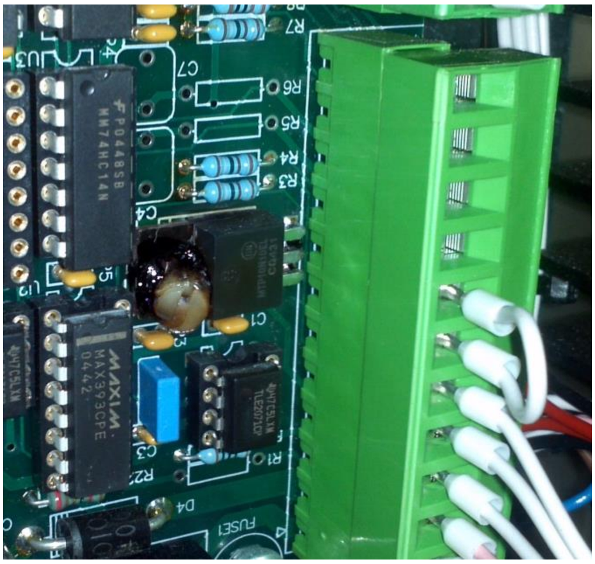

Photo 1: Overheated FET that drives the operating light.

Photo 2 and 3: Water ingress in enclosures.

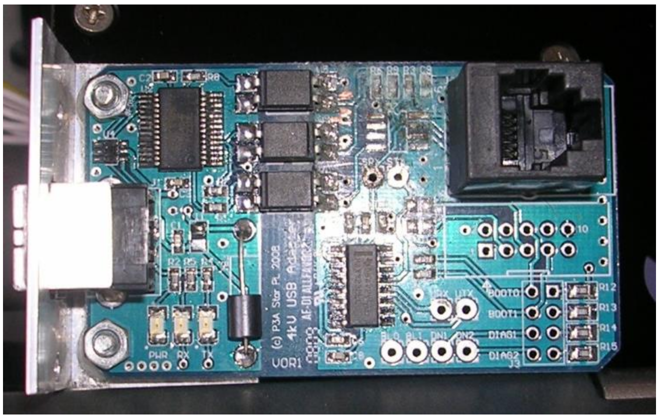

Photo 4: Corrosion on PCB with surface mounted components.

Photo 5: Worn stainless steel electrode as a hygiene issue.

4.4 Future service of Applied Sorting Technologies equipment

Continued operation of the Applied Sorting Technologies (AST) equipment was seen as very important by processors using the equipment (90% of those visited). The equipment operates in process critical roles and no spares are held on site nor currently available. Processors were critical of the support for the AST equipment having ended.

The meeting with Alan Boyle from Applied Sorting Technologies (AST) was more positive than previous discussions regarding the future support for the AST range of equipment. Alan considers he will continue for another 6 months at 1-2 days per week. Although no spares are held for any equipment, printed circuit boards and transformers could still be produced in low numbers. AST have provided StimTech with an outline of means to produce a low number of critical spares, which production of would ensure the information required for future production is correct. AST would also produce documentation to enable future production of spare parts and servicing of equipment in conjunction with StimTech.

Applied Sorting Technologies has since been purchased by Scott Technologies with discussions early in the takeover period being positive towards the continued supply of spares for the range of equipment.

4.5 Site interview questionnaire

Table 3 and 4 provide a summary of the questionnaire results; however, all site interview questionnaires are available as a separate file on request.

The review of 14 plants with existing electrical intervention technologies across small and large, beef and lamb processing operations showed that visual carcase response and measurements of carcase pH is industry practice to monitoring the correct operation of the range of electrical input equipment. The majority of plants would like formal training in “what is a correct response” and evidence suggests this knowledge is lacking throughout the industry including on site personnel, Department of Primary Industries and Meat Standards Australia. Only one processor surveyed had test equipment suitable to test the intervention technology and most sites did not have personnel with current skills to use such equipment. Processors on site test capabilities are limited to the electrical supply to the equipment and the field wiring. Processors would like a means of measuring the output of equipment with the majority wanting this to be in real time and recorded automatically as well as measurement equipment to quantify the output waveform.

A common “general” theme was established from the results of the interview questionnaire.

- Processors understood the importance of the electrical input equipment.
- Equipment operation was monitored and recorded.
- pH decline non-compliance is very rare.
- Visual assessment of the carcase response determined equipment operation.
- Measurement of equipment operation and output valuable.
- Want monitoring fed back into their plant operating system e.g. SCADA.
- Annual audit of the equipment deemed suitable.
- Processors accepted StimTech pricing but preferred costs met by MLA.
- Training would be best suited to be hands-on, on site and site specific delivered by authority on the equipment.
- On-site training would be backed up with manual and visual aids of carcase response.
- Processors were concerned about AST equipment support ending.
- Spare parts, equipment service and knowledge of electrical inputs integration to processing is valued.
- Processors do not carry spares and accept they can’t process without the equipment for long.

A number of sites had equipment that was not operating correctly and their systems for monitoring the electrical inputs performance had not recognised the issues. The “system” fails by sites not accurately knowing what their equipment is operating at and what the correct response should be. MSA TDO’s and DPI Officers during the site visits also demonstrated that although they were knowledgeable of electrical inputs, recognising the correct carcase response wasn't always straight forward.

Table 3: Beef Processor Questionnaire Summary

		Company							
Focus Area	**Question**	**Plant 1**	**Plant 2**	**Plant 3**	**Plant 4**	**Plant 5**	**Plant 6**	**Plant 7**	**Plant 8**
Compliance	Compliance issues or equipment failures	BS after installing remote switching. LVES remote LCD failed after water ingress.	Broken backs and bungs being pushed out.	Replacement stimulator remote control.	Moisture in the enclosure.	Jarvis LVES as Immobiliser had a failure on the board.	Broken wires on BS. LVES has previously failed. pH decline is close to the cold end.	Loose and broken wires. Failed module. Misaligned stepping chain.	LCD modules failed on small stock MVES. Dark cutters can be compliance issue.
	How was it detected	Carcase not responding to BS. LCD not lighting up. Detected by operators.	Visual response from production and supervisors.	Six position switch became difficult to operate.	Indicator outputting light not operating, discovered blown fuses.	Visually by the operator, QA or supervisor.	Equipment operator and floor supervisors.	QA check noticed the wire hanging down.	Operators noted LCD was not working.
	What action was taken to remedy	Site electrician investigated. StimTech contacted for site visit.	Electrician test. Contact StimTech.	Contact StimTech for repair/replace on site.	Received loan unit and sent away for repair. Relocated to dry area.	Swapped board and returned it to the manufacturer for repair.	Repaired by on site electrician.	Maintenance reattached the wire.	Rang StimTech who supplied a spare module. Site fitted the replacement.
	Who is responsible for safe operation	Kill floor foreman and personnel.	OHS. No work practice but trainer instructs, sign off as trained.	Electrician, safety officer and SOP.	OHS of overall slaughter floor. Risk control.	Work order to test equipment is functioning correctly. SOP.	OHS committee. Pre-op maintenance.	Supervisors on the floor, maintenance and OHS.	Maintenance manager.
Monitoring	Who is responsible for monitoring	QA manager. QA officer.	QA, QC, Supervisors, BS pre op by maintenance. LVES QC turns on for grass.	QA and operators.	QA and supervisor.	Pre-op maintenance check, operators, QA and production supervisors.	Supervisor and QA.	QA and MSA coordinator.	Maintenance pre-op. Operators in area.
	How do you monitor	Carcase response and pH decline.	Visual response. MSA grader checks 10/day.	Visual check of carcase response 10/2 hours. Broken backs.	Visual assessment of actively moving.	Visual. BS test voltage at probes. Test light for immobiliser. LVES 100Ω resistor and oscilloscope.	Visual response by QA 3/day to give a daily sheet checking inputs.	Visual carcase response measured daily.	pH on beef. No pH on mutton. Visual assessment of operation.
	Do you keep records	Daily response from 10 animals.	Ileader, twice per day for 10 animals.	Meat hygiene assessment program.	N0.	Yes. Recorded by QC into Ileader. Reviewed by QC.	Yes. Daily record.	Recorded on form 12, small stock MHA process.	No.
Training package	What format of delivery	On site by recognised training provider.	Hands on, on site, site specific, with manuals and DVD or web.	Onsite training of foreman and trainers. DVD/website, hard copy manual.	On site, hands on, wed or DVD for back up information.	On site, hands on, site specific with supporting documentation, access to web or DVD.	Hands on, on site and site specific with written and visual material. Documents into training records.	On site, hands on, site equipment specific.	Centralised training with documentation to accompanying.
	Who should be involved	Training officer.	Trainers, QC, QA, supervisors, electrician.	Foreman, QA's, trainers, operators and electrician.	Electrician and maintenance, QA, supervisors and trainers.	QC, production supervisor, maintenance supervisor and	QA, supervisor and maintenance.	Maintenance, electrical contractor, QA staff and supervisors.	Owners, maintenance, QA and production supervisors.

						trainers.			
	Will training be of benefit	Yes, Through safety and better knowledge.	Yes. Knowledgeable operators, improved and consistent quality	Yes. Better picture of system and allay fears of electrical danger.	Yes. Dark cutters issue and training on integrating all equipment and its effect very useful.	Of course! All training is good training.	Yes, knowledge of failure mode.	Yes.	Yes.

		Company							
Focus Area	**Question**	**Plant 1**	**Plant 2**	**Plant 3**	**Plant 4**	**Plant 5**	**Plant 6**	**Plant 7**	**Plant 8**
Capability	Who monitors equipment operations	QA performs visual checks.	Electrician for BS at start up.	QA visual 10/2 hours. pH decline every 2nd week of 20 per run.	Supervisors monitor "it it's on, it's on".	Visual monitoring by operators and production supervisor and QC. Pre-op maintenance.	Maintenance pre-op check, QA visual checks of carcase response.	Can't measure, pre-op check report current from AST LCD screen. (Note: is not output current!)	QA performs visual checks.
	What can you measure, monitor or service	Field wiring and visual monitoring.	Field wiring and visual monitoring.	Field wiring and visual monitoring.	Field wiring and visual monitoring.	Service field wiring and peripheral equipment. Visual response of carcase. Measure BS and LVES.	Can measure 50hZ of BS and 100Hz of LVES. Visual response of carcase.	Field wiring and visual monitoring. Monitor LCD display (note: is not output current!)	Unable to measure. Change parts under instruction. QA checks operation ad hoc.
	Who would use measuring equipment	Electricians unless simple Y/N in line test.	QA and maintenance. QA, Y/N for correct operation. Electrician specialised.	QA and electrician.	Electrician or QA.	QC and production supervisor if monitoring. Maintenance if testing operation.	QA monitoring.	Maintenance to do it and QA to verify it is being done.	Maintenance and electricians.
	Measuring equipment, basic or technical	Rely on visuals and then have electrician test with technical.	Basic for QA, technical for electrician.	Oscilloscope for electrician. Basic for QA.	Depends on user.	Depends who is to use it.	Basic for QA but electrician would like oscilloscope.	Depends who is to use it. Rely on visuals and get electrician to test with measurement.	Either. If technical would require training on the equipment.
Service and delivery package	What do you require	6 monthly audits. Service available from supplier with parts on hand.	Annual audit, service of equipment, spares and processing advice.	Annual 3rd part electrical input audit. Combine with MSA visit if they could conduct checks.	6 monthly audits unless on line monitoring is occurring.	Annual test. Spare parts and technical skills. Feedback and improvement of the product.	Spare parts and audits as suggested by the service provider.	Nothing – the equipment doesn't fail.	Annual check of equipment, supply spare parts and service of equipment.
	Appropriate cost	Cost supported by industry levies. $570+GST.	$4,000+GST. Reduced if going to several sites.	Normal is $600+GST. Would accept $1,000+GST/day out of Brisbane.	$1,500 - $2,000+GST	Annual.	$1,000+GST.	NA	Annual, cost reflective of service, $2,000+GST.
	Have you requested service	Yes. StimTech.	Yes.	Yes. StimTech.	Yes. StimTech.	No.	No.	No.	Yes. StimTech.
	If an input fails how long can you process	Imm – keep running unsafely up to 1 week. Stim & BS – revert to old system.	Imm – slow down. Stim – keep killing, intensified check of decline, downgrade for 1 day. BS would use 1 only for 1 day.	Imm – complete kill at slower pace. OHS issues. LVES – keep processing non-MSA. BS – keep killing 1-2 days.	Keep producing non MSA. If BS fails can go half speed and only use one BS.	No go! Have a 2nd BS if required.	Reschedule MSA cattle but continue kill on non MSA, slow kill for HFI. Get by for a little while.	Total failure results in non-MSA. If only a few modules would kill at a slower rate.	Mutton – until it can be fixed. HFI – stop immediately, but, if no solution would run slower and wait for movement to subside.

Table 4: Sheep Processor Questionnaire Summary

		Company							
Focus Area	**Question**	**Plant A**	**Plant B**	**Plant C**	**Plant D**	**Plant E**	**Plant F**	**Plant G**	**Plant H**
Compliance	Compliance issues or equipment failures	2 LCD display failures. No pH issues after initial adjustments.	VOHFI and HFI. VOHFI insulators need routine replacement. LVES electrodes need routine servicing. MVES has broken wires and needs electrodes and insulators replacing.	3-4 output modules within first 12 months. After mains power filter supplied no further issues.	Have had sheep LVES boards fail.	Broken wires and failed modules.	Last decline was at cold end. Had a broken wire to one module.	Loose and broken wires. Failed module. Misaligned stepping chain.	LCD modules failed on small stock MVES. Dark cutters can be compliance issue.
	How was it detected	Found when checking the cabinets.	Slaughter floor workers and foreman. QA	Monthly pH declines and carcase response.	Visual carcase response, qualified with test lamp supplied.	Visual assessment.	pH decline. Visual pre-op found wire hanging down.	QA check noticed the wire hanging down.	Operators noted LCD was not working.
	What action was taken to remedy	Site electricians checked then contacted StimTech who replaced them.	Maintenance repaired field wiring and lights. StimTech repaired equipment.	Boards repaired and mains line filter installed.	Installed swap boards and had faulty boards repaired.	Sent boards to StimTech for repair. Maintenance reconnected wire.	Electrician attached wire.	Maintenance reattached the wire.	Rang StimTech who supplied a spare module. Site fitted the replacement.
	Who is responsible for safe operation	Last person on the chain. OHS for risk assessment.	Daily start up checks by electricians. SOP's. Rely on supplier doc's for safety requirements.	Maintenance on pre-op check. All staff inducted and instructed on electrical safety of stimulator.	Personnel working in the area, OHS and electrical work safety.	Maintenance and safety officer.	Slaughter floor foreman.	Supervisors on the floor, maintenance and OHS.	Maintenance manager.
Monitoring	Who is responsible for monitoring	QA for the area.	QA, supervisors, maintenance, work instructions for areas with electrical inputs.	Maintenance personnel turn on and off. Shut down and lock out procedure. QA's.	AusMeat officer checking carcases and maintenance during pre op using test lamp.	QA.	QA	QA and MSA coordinator.	Maintenance pre-op. Operators in area.
	How do you monitor	Check stim duration and correct setting. Visual check carcase response. Monthly pH decline.	Visual assessment of carcase response by personnel, maintenance and QA's.	Observe indicator lights (Don't work!). Visual response and pH decline.	Visual carcase response.	pH decline. Assessment of visual response 3 times per day for 2 animals each time.	Visual carcass response.	Visual carcase response measured daily.	pH on beef. No pH on mutton. Visual assessment of operation.
	Do you keep records	Ausmeat form for visual assessment of 10 carcases.	Yes. Ileader.	Yes.	Yes.	Yes. AusMeat form.	Records of chain speed and current setting.	Recorded on form 12, small stock MHA process.	No.
Training package	What format of delivery	Onsite training, third party written information and DVD/web.	Hands on, in house training specific to site equipment.	Hands on, on site, training specific to equipment on site. Training manual with DVD or website.	On site, hands on. Produce a site specific working document to be used by site trainers.	On site one on one or a group. Needs to be delivered by "technically savvy" with electrical and muscle physiology knowledge. DVD/web page.	Onsite face to face.	On site, hands on, site equipment specific.	Centralised training with documentation to accompanying.

	Who should be involved	QA's, foreman, managers, maintenance.	QA, training department, slaughter floor foreman and maintenance.	QA, maintenance and supervisors.	Trainer, QAM, maintenance and QA officers.	Electrician, QA, slaughter floor foreman, training officer and OHS.	Maintenance, electrician, QA and foreman.	Maintenance, electrical contractor, QA staff and supervisors.	Owners, maintenance, QA and production supervisors.
	Will training be of benefit	Yes, through improved knowledge of carcase response.	Definitely.	Yes. Never a bad thing.	Absolutely.	Yes. Need carcase response education.	Yes.	Yes.	Yes.

		Company							
Focus Area	**Question**	**Plant A**	**Plant B**	**Plant C**	**Plant D**	**Plant E**	**Plant F**	**Plant G**	**Plant H**
Capability	Who monitors equipment operations	QA	Electricians.	Electrical personnel on pre op start up. Maintenance visually monitor the carcasses or lights (don't work).	Maintenance start up pre-op check. Scheduled monitoring is not a part of AusMeat.	QA.	QA perform pre-op check. 2 checks per day of stimulator setting. Scale operator monitors visual response.	Can't measure, pre-op check report current from AST LCD screen. (Note: is not output current!)	QA performs visual checks.
	What can you measure, monitor or service	Visual response. Service field wiring, field hardware and power supply.	Visual carcase response, lights are on, use test lamp during pre-op. Service field wring and electrodes. Hot spares for VOHFI, HFI and LVES.	Monitor external lights (don't work). Can replace boards.	Can use test lamp on output but no measurement. Visual response. Service mains supply and field wiring and equipment.	Visual response. Service field wiring and equipment and swap boards under instruction.	Visual response. Service field equipment and swap out boards under instruction.	Field wiring and visual monitoring. Monitor LCD display (note: is not output current!)	Unable to measure. Change parts under instruction. QA checks operation ad hoc.
	Who would use measuring equipment	Electricians.	Electricians.	QA or electrical depending where measurements to be taken from.	QA/maintenance two hourly checks and record.	Slaughter floor monitoring. Light for each module showing it is operating correctly. SCADA.	QA.	Maintenance to do it and QA to verify it is being done.	Maintenance and electricians.
	Measuring equipment, basic or technical	QA's - simple. Electricians – technical.	Basic.	Basic for QA's and technical for electricians.	Basic for ease of monitoring and recording.	Basic but linked into SCADA.	Basic.	Depends who is to use it. Rely on visuals and get electrician to test with measurement.	Either. If technical would require training on the equipment.
Service and delivery package	What do you require	MLA to pay. Prefer site internal audit. Annual external audit for good practice.	More than once a year.	Annual check, but, everyday monitoring through SCADA would be better.	Don't see a need. Jarvis stim on sheep and HETech tenderpulse on beef. No BS.	Spare parts and technical support.	No requirement for service until a failure occurs.	Nothing – the equipment doesn't fail.	Annual check of equipment, supply spare parts and service of equipment.
	Appropriate cost	Annual $1,200 + GST. $1,400 questionable.	Current cost of $4,300+GST acceptable. Would question at $5,000.	Zero cost annually.	Part of MSA at no cost.	Annual. $1,600 - $1,800+GST. If multiple sites proportion travel costs plus time on site.	NA.	NA	Annual, cost reflective of service, $2,000+GST.
	Have you requested service	Yes, StimTech.	Yes. StimTech do an annual audit.	Yes. Realcold Milmech. Chris Mudford.	Yes. Repair of LVES board.	Yes.	No.	No.	Yes. StimTech.
	If an input fails how long can you process	Mutton 3 hours each day without stim. Lamb would kill but non MSA. If one unit failed would continue at half speed.	Cannot process without VOHFI and HFI. Nothing else matters.	Want it running ASAP, but, could be a week and would produce non MSA.	Would keep processing without stimulation.	Perform pH decline immediately to determine grading MSA or non-MSA. Within 3 hours would know the result.	Downgrade to MSA for the remainder of the day. Would need unit operable by the next day.	Total failure results in non-MSA. If only a few modules would kill at a slower rate.	Mutton – until it can be fixed. HFI – stop immediately, but, if no solution would run slower and wait for movement to subside.

5 Summary, conclusions and industry implications

5.1 Summary

Phase 1 has shown that the industry is operating without specific regulations governing the use of the electrical input equipment with the majority of sites unable to measure the output of the equipment. Maintenance of the equipment is “when it breaks down” which is detected by visually monitoring the carcase physical response. However, the practice of visually monitoring the physical response is flawed with limited knowledge of the “correct physical response” and details of the equipment operating conditions.

Sites want the skills and means of measuring the performance of the equipment but consider generic measuring equipment is not suitable for Quality Assurance personnel that would conduct the measurements. Different facilities wanted varying ability to link measurement equipment to their site control systems. A training package would be best delivered on site and hands on by personnel with working knowledge of the sites specific equipment.

5.2 Conclusions

Phase 1 has shown that the 14 processing sites visited do not have the knowledge, skills, or measurement equipment to ensure that their electrical intervention equipment is operating correctly and as such a number of sites had faulting equipment. However, because the present industry system for measuring and reporting pH compliance does not identify an issue they see little need to ensure their electrical intervention technology is operating correctly other than for it to appear to be working, electrically safe and ensuring personnel safety.

Assuming the 14 sites surveyed are a true representation of the Australian meat processing industry it is concluded that similar levels of equipment maintenance and performance exist throughout the industry and that there is a lack of industry ability to monitor and maintain their electrical input equipment.

5.3 Industry implications

The findings of phase 1 imply that the Australian meat processing industry is producing a proportion of product that would be of suboptimum meat eating quality. The proportion is unknown, but previous research publications have shown 50% and greater non-compliance to the MSA pH verses temperature decline.

Many sites inability to validate the operating parameters of their electrical input equipment and few having external audits conducted would place their electrical personnel and management answerable to the safety provided to personnel operating in the vicinity should an incident occur.

6 Recommendations

6.1 Regulatory status

It is recommended that NZS6116:2006 is made a joint New Zealand and Australian Standard. This will give the Australian meat processors a regulation to work to with regards the equipment's safety, installation requirements and maintenance regime. However, this would require the formal backing of the Australian Meat Processing Industry as many site electricians commented they "don't need another set of regulations to work to!"

6.2 Testing and monitoring at a plant level

Results showed that a basic piece of measuring / monitoring equipment was wanted by the majority of plants if manual measurements and monitoring was to be undertaken. However, many processors were interested in an "on line" monitoring system that recorded results for individual carcasses and raised an alarm when the stimulation was outside parameters.

There is no commercially available equipment to meet the requirements of the Australian meat processing industry. Currently monitoring the visual response of the carcase is the best method of ensuring stimulation is occurring.

It is recommended that workshops be developed to instruct and illustrate the correct and incorrect carcase response for all electrical inputs utilised by Australian meat processors.

6.3 Further research and development

6.3.1 Conduct Phase 1 to cover the entire red meat industry

Conduct phase 1 for all producers, specifically targeting the electrical intervention equipment audit and the questionnaire. To coincide with this should be an independent measurement and analysis of the pH decline. This will give a benchmark level of equipment functionality and producer compliance to the MSA pH verses temperature decline for the entire industry.

6.3.2 Develop a broad capability program

Develop a broad capability program with the purpose of developing the appropriate skills and capability amongst the industry with all plants owning and operating any of the suites of electrical intervention technologies as outlined in section 1.2. This would focus on the development of measurement equipment (6.3.3) training packages on its use and implementation for internal auditing (6.3.4) i.e. stage 2 and 3 of the outlined broad capability package.

6.3.3 Equipment for testing and monitoring

Develop test equipment and protocols for its use to test and monitor electrical input equipment used in the Australian meat processing industry. The equipment should be suitable for three tiers of operation.

a. To be portable and applied across a dummy load connected to the electrodes or directly across the electrodes i.e. carcase measurement.
b. To be installed and switchable between measuring across a dummy load or carcases.
c. To be installed and switchable between measuring across a dummy load or carcase and results available across a LAN or SCADA.

The measuring apparatus should be programmable to each piece of equipment and each program setting to give a pass/fail for each parameter.

6.3.4 Internal auditing and training package

Develop an internal auditing and training package to enable sites to operate and maintain their equipment with the use of the test equipment. This would be a hands on program with supporting documentation delivered on site to managers, QA and maintenance. The training package should cover the importance of the equipment and its correct operation, visual signs of incorrect operation, maintenance and reporting regime. The training needs to be delivered by personnel knowledgeable in the field (compared with someone reading from a book). Mintrac has engaged StimTech to present maintenance workshops with a positive response from attendees.

6.3.5 Industry external auditing package

Develop an industry external auditing regime for carcase pH decline and equipment operation and safety. The current MSA carcase pH decline protocol could be used as a model to base development of a more robust sampling method to deliver a true measure of the product supplied to consumers rather than a validation of the sites process. This would include the number of carcases to be tested, frequency of testing and method of analysis.

References and Acknowledgments

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6.5 Acknowledgments

6.5.1 Site visit facilitators

Demelsa Lollback, Trade Development Officer, Meat Standards Australia.

David Jones, Operations Manager - Sheep, Meat Standards Australia.

Murray Patrick, Field Operations Manager, Meat Standards Australia.

Matt Dorney, Trade Development Officer, Meat Standards Australia.

John Simmonds, Trade Development Officer, Meat Standards Australia.

6.5.2 Personal conversations

Kelly Pearce, Cooperative Research Centre for Sheep Industry Innovation, Murdoch University.

David Hopkins, Senior Principal Research Scientist (Meat Science), New South Wales Department of Primary Industries.

Edwina Toohey, Beef Development Officer, New South Wales Department of Primary Industries.

Dean Gutzke, Innovation Development Manager, Meat and Livestock Australia.

6.5.3 Industry participants

Applied Sorting Technologies, Melbourne.

Processors – Commercial in Confidence.