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Further Development of Pneumatic Sheep Stunner and Oesophagus Sealing Applicator

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EXECUTIVE SUMMARY

This report details a joint industry project in which SFK trialled the use of a pneumatic mushroom head stunner on sheep and FSA investigated the complimentary application of a rigid oesophagus plugging tool and plugs for the purpose of better managing ingesta contamination.

The first stage of this project was to conduct plant based trials at Devonport City Abattoir (DCA) to ensure that, following the use of the SFK mushroom head pneumatic stunner, the sheep would be in a physical condition that would allow the current prototype sheep oesophagus tool to deposit the plugs and effectively seal the oesophagus. The trials were conducted over three days.

10/11/2004

1) Trialed two runs of approximately 20 sheep.
   Project staff were able to use a temporary platform at the discharge end of the restraint which allowed good access for the insertion of the applicator and plugs. The platform obstructed a passageway and hindered DCA operations and therefore had to be removed. All subsequent trials were carried out further back in the restraint, which proved to be a less than ideal location due to the difficulty in accessing consecutive sheep.
   When checked, all plugs were in place with a complete seal. No leaks were observed at evisceration or inspection. Worker feedback stated that the plugs caused no subsequent processing issues, and contamination due to ingesta was reduced or eliminated.

2) A further 100-150 sheep were plugged for training purposes.
   On a few occasions, it was noted that some lockjaw was present due to an inadequate stun. It was found that, in these cases, a second stun allowed the plugs to be inserted. As the stunner operator gained experience, this situation virtually disappeared. Variations in air pressure may have also contributed to these inadequate stuns.

11/11/2004

The aim of these trials was to plug 1000 consecutive sheep at chain speed. Due to the difficulties of plugging back in the restraint, this was not possible. However the results included in APPENDIX A – TRIAL RESULTS show that even under these conditions, it was possible to insert the plugs into 46 consecutive sheep. As the chain was not held up in any way by the trials, this indicates that plugging at the DCA chain speed can be achieved.

A total of 475 sheep were plugged with 48 classed as unsuccessful.

From observation at the time of the trials, and a reasonable interpretation of the results in APPENDIX A – TRIAL RESULTS, 31 of the unsuccessful attempts can be attributed to the limitations of the prototype oesophagus sealing tool.

There were 18 unsuccessful attempts to seal the oesophagus caused by grass being present. These are included in the overall results shown below.

12/11/2004

1) The first trial plugged 41 consecutive animals with 6 unsuccessful seals – 4 attributed to grass preventing the plug functioning and 2 to reasons outlined above. These consecutive carcasses were plugged at line speed.

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2) The final trials plugged a total of 87 sheep with 1 grass failure and 1 other. All plugs were found in place and secure.

After examining the issue of plug failure not related to grass, in particular associated with current prototype tool simplicity and operator skill requirement, it was felt that, based on reasonable assumptions, a plugging success rate of 96% could be expected. Further improvement could be obtained with a more complex tool but benefits gained would need to be evaluated.

The use of the pneumatic stun gun eliminated the lockjaw problem associated with electrical stunning, and allowed the successful application of oesophageal plugs.

The VB125 stunner had an "o" ring failure during trialling that was not possible to repair. A VB225 beef stunner was used for the remaining trials. Trials prior to this changeover had shown the VB125 and plugger to be compatible.

The final recommendations of this project are:

- To proceed to Objectives 2 and 3 of the project.
- A consistent, reliable air supply needs to be guaranteed for effective stun operation
- The remanufacture of the plug applicator to incorporate additional control complexity including automatic cycle control and plug release should be considered.
- Vacuum blockage protection should be provided.

Although not specifically part of this project, the use of plugs from previous projects has shown a reasonable plug shelf life for commercialisation.

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1. INTRODUCTION

Past projects by Food Science Australia (FSA) have produced an internal oesophagus sealing system for beef cattle and a further developed scaled down version to suit sheep. The systems use a "plastic plug and ring" arrangement combined with a vacuum system to seal the oesophagi of beef and sheep. As with the beef sealing, the sheep sealing system provides an improved method of oesophagus sealing without the risk of contamination associated with entering the body through the dirty hide/pelt.

The internal oesophagus sealing system also reduces contamination as a result of leakage from the oesophagus. The plug is applied immediately after stunning and prior to the throat being cut. Existing oesophagus sealing methods require the throat to be cut before occlusion takes place, with a risk of leakage occurring during this interval. Correctly applied oesophagus plugs provide an effective seal. There is a zero tolerance on contamination from paunch contents, and the plugs provide a seal before any entry is made to the body cavity. They also prevent contamination of the blood during bleeding.

Weasand clips are currently being used by most sheep processing plants to perform oesophagus sealing and cost approximately 5 cents each. In the developed plugging process, the clips are replaced by plugs costing a predicted 3 – 5 cents each once in production.

SFK has recently experimented with a pneumatic mushroom head stunner for sheep. To use the FSA oesophagus sealing tool an operator has to be able to open the sheep's mouth to insert and position the plug into the oesophagus, which has been an issue with sheep that have been electrically stunned. As SFK currently had the new pneumatic stunner undergoing site trials at a processing plant in Tasmania it was a good opportunity to trial and further develop FSA's rigid oesophagus sealing tool and plugs, without the "lockjaw" that can be caused by electrical stunning.

Using the MLA/AMPC "Plant Initiated Project Application Form" Fletchers have initiated a project in conjunction with FSA and SFK which will investigate and develop further both the pneumatic stunner and prototype sheep oesophagus plug applicator. This milestone is the first stage of this project with trials conducted at Devonport City Abattoir (DCA) in Tasmania, although not used at the processing speed required by Fletcher's. The sheep oesophagus sealing system incorporating the pneumatic stunner, plugging tool and vacuum system will then be trialed at Fletchers Sheep Processing Plant in Albany WA for a specified period to prove the process once the required validation and religious approvals have been obtained.

2. PROJECT OBJECTIVES

Objective 1 - Proof of Pneumatic Stunning Tool Operation and Efficacy with Plugging Tool

The first objective of this project was for SFK and FSA to conduct plant based trials at Devonport City Abattoir (DCA) to ensure that the pneumatic stunner operates in such a way that the current sheep oesophagus sealing tool can deposit the plugs and seal effectively.

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3. METHODOLOGY

Milestone 1 - Preliminary Investigation - Proof of Pneumatic Stunning Tool Operation and Efficacy with Plugging Tool

The first stage of this Project was to determine if pneumatic stunning leaves the sheep in such a state that the oesophagus sealing tool can be used to successfully plug each animal.

It was planned that the trial at DCA would be conducted over 3 days. The first day was for setting up, experimentation and training of a DCA operator. Day 2 would be a production run where an attempt would be made to plug 1000 sheep consecutively. Day 3 was for further trialing or experimentation as required.

An MLA representative was to be provided to assess the effectiveness of the seal. Unfortunately, this independent witness was not available at the time of trialing. This meant the project team was unable to check the seal for most of the trial. To determine the effectiveness of the plugs, 4 batches of 20 – 30 sheep were plugged and inspected. The size of these batches was limited by the number of bodies between the stunning and rodding stations where inspection took place. The sheep had to be plugged, before personnel could move to the rodding station to record the results. This process was then repeated for the 4 batches.

Plugging is normally carried out at the discharge end of the restraint conveyor. This allows convenient access to the mouth immediately after stunning, and just before sticking. Apart from a short demonstration trial on Day 1, this location was not available for most of the trialing. Space and safety issues made it necessary to apply the plugs further back in the restraint. The presence of a sheep ahead of the one being plugged often prevented access to the mouth, and plugging had to be aborted. To minimize disruption, DCA staff operated as usual with all sheep being electrically stunned, whether they had been plugged or not.

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4. RESULTS & DISCUSSION

4.1. *Trials carried out on 10/11/04*

An initial trial was carried out to test and demonstrate the equipment. Plugging was carried out in the "usual" position at the end of the restraint. Due to the layout of the plant, this required the operator to stand on a temporary platform. Two trials of approximately 20 consecutive sheep were plugged successfully. The Schmid and Wezel "E.F.A. VB125" pneumatic mushroom head stun gun was used for this trial. There was no sign of lockjaw, the stun appeared effective and plug insertion was straight forward.

The plugged carcasses were followed through to the rodding station and inspected. All plugs were in place and provided a secure seal. Clearing of the weasand was carried out with a conventional "pigtail" rodding tool without any difficulty or dislodging of the plugs (Figure 4-1). No leakage was observed at evisceration or inspection (Figure 4-2). Worker feedback was that the plugs caused no problems during processing, and that contamination due to ingesta was reduced or eliminated.

Figure 4-1 Rodding with plug in place

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Figure 4-2 Plug secure after evisceration

The temporary platform was removed by DCA staff as it obstructed a passageway and hindered their operations. All subsequent trials were carried out further back in the restraint which proved to be a less than ideal situation. The depth of the restraint made it difficult to reach the head of the sheep (Figure 4-3), and preceding sheep often made it difficult to access the head of the sheep being plugged. The restraint also indexed forward unpredictably making plugging difficult (Figure 4-4).

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Figure 4-3 Lifting head after stun

Figure 4-4 Restraint moves without warning

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Approximately 100 – 150 sheep were plugged. These were not inspected as the main aim was to train Wayne Gaskell (DCA Production Manager) in the use of the plugging tool.

On only a few occasions, it was noted that some lockjaw was present as the animals had not been effectively stunned. It was found that, in these cases, a second stun allowed the plugs to be inserted. As the stunner operator gained experience, this situation virtually disappeared.

It was also noticed that the air pressure varied noticeably due to demand in the plant. The operator could feel these variations while using the stunner and these variations may have also contributed to the few ineffective stuns.

4.2. *Trials carried out on 11/11/04*

The aim of these trials was to plug 1000 consecutive sheep at chain speed. Due to the difficulties of plugging back in the restraint, this was not possible. However the results included in APPENDIX A – TRIAL RESULTS show that even under these conditions, it was possible to insert the plugs into 46 consecutive sheep. As the chain was not held up in any way by the trials, this indicates that plugging at the DCA chain speed can be achieved.

Plugging was attempted on 475 sheep.

Of these attempts, 48 were not successful. In 18 cases, the plug came out still attached to the applicator and covered in grass. While the plug is designed to handle some grass in the area of application, it cannot handle a full weasand. The existing applicator inserts the plugs in an open condition, which leaves them vulnerable to the grass. A more complex applicator can be used to reduce the problem by inserting the plugs in a semi closed position. This reduces the risk of the grass interfering with the plug operation, but does require a heavier, bulkier tool that may affect cycle time slightly. Many of the sheep were eating up until shortly before processing, and previous trials have shown that some fasting reduces the grass problem. Stunning at the end of the restraint should also reduce the effect of the grass as the head can be raised back up immediately after stunning and reduce the time available for leakage to occur.

On two occasions, it was found that the pneumatic vacuum generator was blocked. It is likely that many of the unexplained failures were due to the same cause. The addition of a transparent accumulator in the vacuum line would allow this type of malfunction to be avoided. A more complex control system would be required.

There were 17 unexplained failures. Some of these were likely due to blocked vacuum. The rest were probably due to operator error. Both operators plugged approximately the same number of sheep, yet the failures were distributed 15 to the less experienced operator and 2 to the more experienced. This indicates that a more automated control system should improve reliability as there would be less operator skill requirement.

On 11 occasions, the plug clamped and sealed the oesophagus but would not release from the front of the applicator. In some of these cases, the oesophagus was damaged by the force needed to remove the tool. This problem has not been observed in any other previous trials, and the cause is not obvious. The current prototype tool requires the whole tool to be rotated in the oesophagus to release the plug. It is thought that the plug and tool are sometimes rotating together and preventing them separating. It is likely that changes to the applicator to make it faster and easier to use will also solve this problem.

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Note: The VB125 stunner suffered an “o”ring failure after the first 2 trials on 11/11/04. It was not possible to repair the stunner at the time, and the trials were continued with a more powerful VB225 beef stunner. Trials prior to this changeover had shown the VB125 and plugger to be compatible.

4.3. *Trials carried out on 12/11/04*

The purpose of these trials was to check the operation of the plugs by applying them in batches, then inspecting the carcasses further down the chain. The first trial consisted of 41 attempts, with 2 unexplained failures, and 4 due to grass. Most of the correctly applied plugs were located at rodding, and were found to be secure.

The final 4 trials plugged a total of 87 sheep with 1 unexplained and 1 grass failure. All plugs were found in place and secure.

The prototype applicator used for these trials is a simple tool designed to investigate the use of a rigid tool. It has a rudimentary control system and relies heavily on the operator to function correctly. It is reasonable to assume that plugging failures not attributed to grass could be resolved by improving the design and control system of the plug applicator. This would give an effective result of 96% of sheep successfully plugged. Further improvement would be possible by using an applicator that inserts the plugs in a semi closed condition. The extra complexity of this tool would have to be considered against the benefit gained.

While inspecting the batches of plugged carcases, DCA staff commented on the noticeable reduction in visible contamination present compared to the conventionally clipped carcases. Figure 4-5 and Figure 4-6 below show this difference.

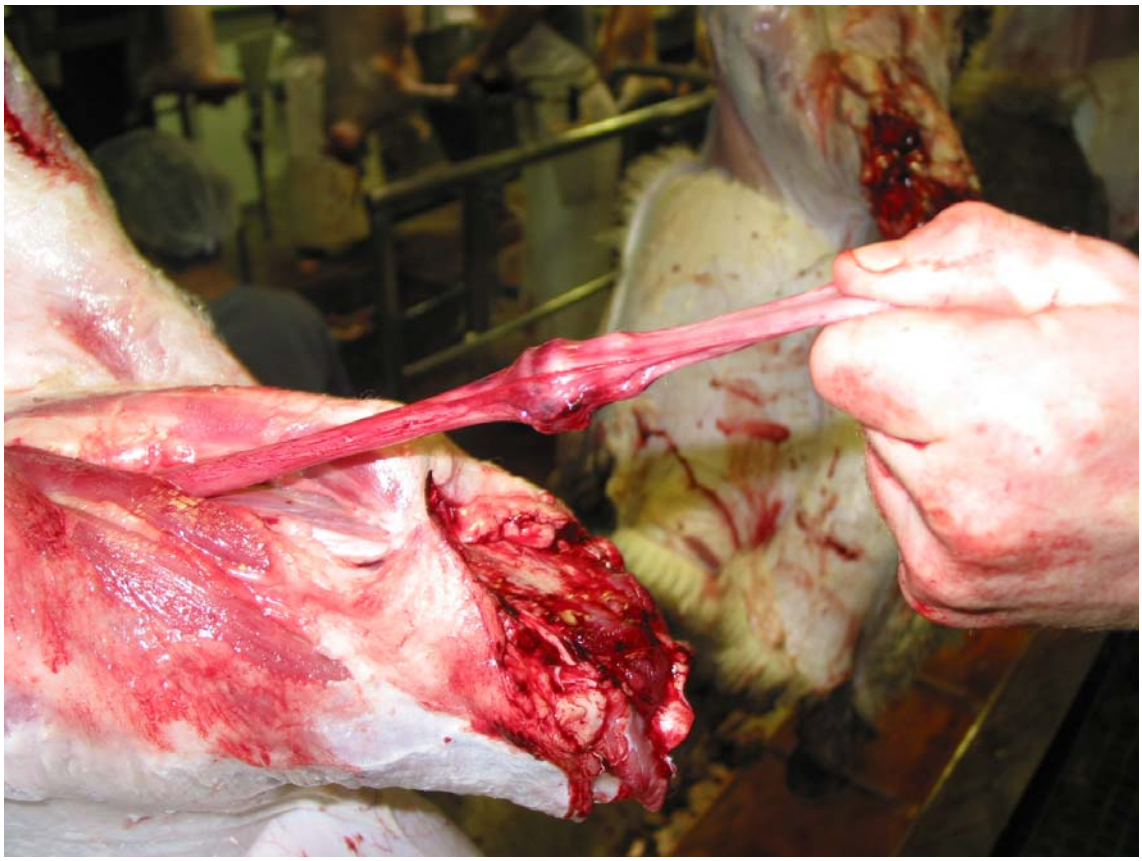

Figure 4-5 With plug

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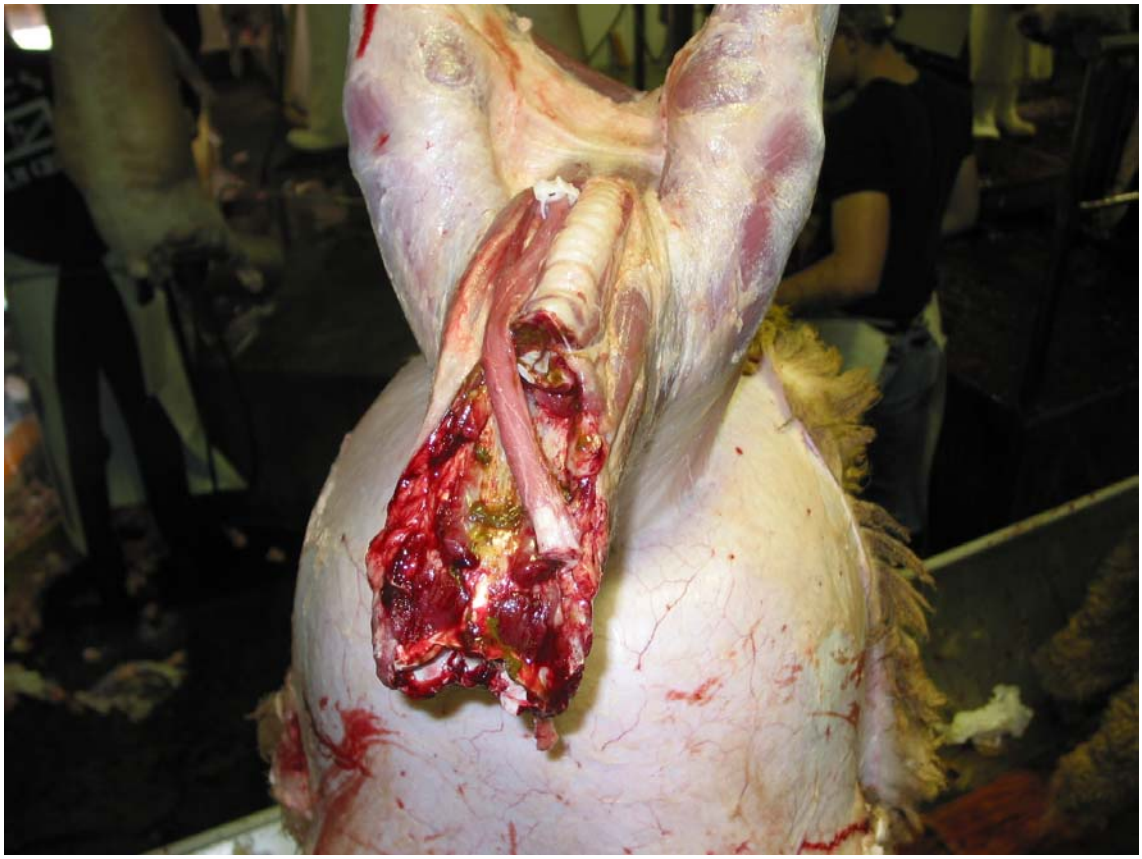

Figure 4-6 Without plug

4.4. *Plug shelf life*

When originally developed in 1997, it was found that if pigmented plastic was used to manufacture the plugs, the rings were not strong enough and tended to break when applied. Changing to a natural version of the plastic solved this problem but indicates that the plastic is operating at close to its limit. There was some concern that the plugs may have a shelf life due to aging. It was decided that some of the original plugs, as well as plugs from the Sheep Jaw Opening project PRTEC.006 from 2002 would be trialed to determine if shelf life is an issue.

No ring failures occurred during these trials. This indicates that the plugs have a reasonable shelf life for commercial application.

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5. CONCLUSIONS

The works trials at Devonport City Abattoir have shown that the use of a pneumatic mushroom head stun gun eliminates the lockjaw problem associated with electrical stunning, and allows the successful application of oesophageal plugs.

By applying reasonable assumptions to the results obtained, a plugging success rate of 96% could be expected.

From observation, the use of oesophageal plugs significantly reduced the incidents and quantity of visible contamination.

Despite a less than ideal task location, plugging at the DCA chain speed of 360/hr was easily achieved. It is anticipated that locating the task at the discharge end of the restraint would also significantly reduce the plugging cycle time.

At present, the plug applicator function is controlled by the judgement and timing of the operator. The trials at DCA have shown that this can be inconsistent, and that automation of the tool control is required.

Comments supplied by Harry Schulz from SFK and Wayne Gaskell from DCA who were also involved with this project have been included in APPENDIX B – Comments By Harry Shultz, SFK and APPENDIX C – Comments By Wayne Gaskell, DCA.

Although not specifically part of this project, the use of plugs from PRTEC.006 and the original plugging project has shown the plugs have a reasonable shelf life for commercialisation.

6. RECOMMENDATIONS

This project should proceed to Objectives 2 and 3 with the following recommendations:

1. Unless a reliable and consistent air supply can be guaranteed, a separate compressor should be used with the stunner.

2. The existing plug applicator should be remanufactured to include a control system that provides automated cycle control and plug release.

3. Vacuum blockage protection should be provided.

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APPENDIX A – TRIAL RESULTS

Legend:

P	-	Pass (No attempt)
S	-	Successful (plug inserted and released)
X	-	Plug inserted but came out still attached to applicator
G	-	Plug inserted but came out still attached to applicator with grass present
NR	-	Plug functions but does not release from applicator
BV	-	Vacuum generator blocked by ingesta

Trial A ***11/11/04***
Chain speed 360/Hr
Stunner: VB125
Operator Harry Schulz (SFK)

Plugger Wayne Gaskell (DCA)

S P S P P P S P S P P P P P X P S S P P P P X P S P P S P S S P S P X S P P X X S S P P P X P P S S P S P P S S P S P X

Trial B ***11/11/04***
Chain speed 360/Hr
Stunner: VB125
Operator Wayne Gaskell (DCA)

Plugger Jeff Owen (FSA)

S S S S S P S P P P P P S S S P S P P S P S S S S X P P G P S S S S S P P S S S S S P S S S P P X S S S

Trial C ***11/11/04***
Chain speed 360/Hr
Stunner: VB225
Operator Harry Schulz (SFK)

Plugger Wayne Gaskell (DCA)

S S S P S S S P P P P S S X P P S S S S S S S P P S S S S S S S S X P S X P S S S S S S

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Trial D ***11/11/04***
Chain speed 360/Hr
Stunner: VB225
Operator Wayne Gaskell (DCA)

Plugger Jeff Owen (FSA)

S S S S S S S S S G NR NR NR NR NR S S NR S S S S S S S S S S S S S S S S G S S S S S S S S S P S S G P P P P P P P S S S S S NR P P S S P S S NR G S S S S S S S S S S S S S S S S S G S S S P G G S S S S S S S S G S S P P S S S S S S S S G S S BV BV P P P P S S S S S S S S S S S S S S S S S S G G S S S S NR S S S S S S P S S S S S S S S S P P S G S S S S S S S S P P G S S S S S S S P P S S S S S S S S S S S P P P S P P P S S S G S S S S S S S S S G S S S S P P S S S S S S S G S S

Trial E ***11/11/04***
Chain speed 360/Hr
Stunner: VB225
Operator Harry Schulz (SFK)

Plugger Wayne Gaskell (DCA)

S S S S S S S S S P P P P S X NR S S S P S S S S S S S S P P P S S S S P S S S P P S S S P S S S S S P NR P S S S S S P P S S S S P P P P P P P X S S P P P S S X S G S P S S S S X P S P S S P P P S S S G S P P P X S P S S P S P P S S S S S P P P S S P P S S S P X P P P P P S P S S P P P P S X P P S P P P P S P P S S X P S S S S X P S X P P P S P P P S X P S P S S S S G S S S S S S S X P S P S S S S S S S S P S P X P S P P P S P P P P P S S G S S P S S P S P S P S X P P P P S S S P S P P P P P G P S S S P S S S P NR P P S P P P P P P P P P S S S P P P G P S P S X S S S S S S P S X P P S S S S S S S P S P S P P P S S P S P S S S S P P P S S S S S

Trial F ***12/11/04***
Chain speed 330/Hr
Stunner: VB225
Operator Harry Schulz (SFK)

Plugger Wayne Gaskell (DCA)

S P P P X S S S S S S S S S S S S S S S S S S S S S S S S S S X S G S P P S S G S S S G S S P S S S G S

Trial G ***12/11/04***
Chain speed 330/Hr
Stunner: VB225
Operator Harry Schulz (SFK)

Plugger Jeff Owen (FSA)

S S S S S S S P S S S S S S S S S S P S S S S

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Trial H ***12/11/04***
Chain speed 330/Hr
Stunner: VB225
Operator Harry Schulz (SFK)

Plugger Jeff Owen (FSA)

S X S S S S S S P P S S S S S S S S S S S P S

Trial I ***12/11/04***
Chain speed 330/Hr
Stunner: VB225
Operator Harry Schulz (SFK)

Plugger Jeff Owen (FSA)

S S S S S S S S S S S S S S S P P S S S S S S S P S

Trial J ***12/11/04***
Chain speed 330/Hr
Stunner: VB225
Operator Harry Schulz (SFK)

Plugger Jeff Owen (FSA)

S S S S P S S P S P S S S S P P S S S S P S S P S G

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APPENDIX B – COMMENTS BY HARRY SHULTZ, SFK

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Ipswich, 25th November, 2004
HS/vt

Subj.: OESOPHAGUS SEALING TRIALS
Place: Devonport City Abattoir
Date: 10, 11 & 12. November, 2004

The sheep/lamb Oesophagus Sealing Trials were conducted at Devonport City Abattoir by Jeff Owen – Food Science Australia and Harry Schulz – SFK Australia, with assistance from Wayne Gaskell – Devonport City Abattoir.

The equipment used was the Food Science Australia "Rigid Proto Type" Oesophagus Sealer, Plugs from Australian Meat Technology and some Plugs that were manufactured for Food Science Australia. The new "E.F.A. VB125" Pneumatic Mushroom Head Stun Gun manufactured by Schmid & Wezel was used during the trials.

SFK Australia is the exclusive agent for Schmid & Wezel's EFA Range of Equipment. Using the "VB125" was compatible with the Oesophagus sealing applicator, as it enabled easy entry to the oesophagus via the mouth. Lock jaw as a result of electrical stunning was not experienced.

Ergonomics during the trials, relating to Restrainer and Sticking Table were not favourable, and would need to be addressed for commercial use during normal production circumstances. However, continuous runs of 40 to 50 were achieved at up to 8 per minute Processing speed. A very high percentage of consistent, total internal oesophagus sealing was achieved.

This success rate clearly indicated the elimination of ingesta spillage and contamination. The trials did not interfere with normal production, nor did the trials create any concerns to the inspection regulators.

In conclusion, it is my opinion, based on results, that this technology has the potential to benefit the Small Stock Processing Industry.
The technology is very dependant on the successful operation of the VB125.

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The VB125, in future, much operate with the EFA compressor, with dual settings, and consistent air pressure for it to comply with animal welfare issues and to also comply with HALAL regulations for the trials at Fletchers in West Australia

For **SFK Australia Pty Ltd**

Harry Schulz
Managing Director

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APPENDIX C – COMMENTS BY WAYNE GASKELL, DCA

Subj.: OESOPHAGUS SEALING TRIALS
Place: Devonport City Abattoir
Date: 10, 11 & 12. November, 2004

Trials held at Devonport City Abattoir on 10, 11 & 12. November, 2004 using the Oesophagus Sealer were in my opinion very successful.

Using the VB125 Stun Gun gave us easy access to the oesophagus via the mouth, as there were no signs of lock jaw.

The plugs worked very well with a perfect seal once I got used to using the proto type sealer.

I was very happy with the results as we were working in awkward conditions to get access to the animal after the stun. To eliminate ingesta, as was displayed during these Oesophagus Sealing Trials, demonstrates potential benefits for sheep and lamb processing.

For **Devonport City Abattoir, Tasmania**

Wayne Gaskell
Production Manager

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