A protocol for verifying the installation and operation of Econoliser units in Australian abattoirs

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AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Government of South Australia
Primary Industries and Regions SA

SARDI
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Purpose

The purpose of this protocol for verifying the correct installation and operation of Econoliser units (Airtech Ltd, Belfast UK) in Australian abattoirs is to facilitate the task of both the establishment and veterinary staff of the Department of Agriculture, Fisheries and Forestry (DAFF) in the event that the establishment wishes to replace a traditional “continuous flow steriliser”, or simply “steriliser”, unit with a two-knife Econoliser.

We provide historical information on knife cleaning to complement the context of this protocol, most notably that the steriliser temperature of 82°C has no known scientific validity *per se*, and that there have been extensive studies on alternative temperatures and times for knife cleaning of which the Econoliser may be considered the latest of alternative procedures.

The protocol developed here draws extensively on data gathered during AMPC Project 2024-1002, when trials were carried out at two beef and one sheep abattoir, comparing the effectiveness of knife cleaning by sterilisers and Econolisers installed at various stations. The microbiological condition of knives cleaned by each system led to an assessment of equivalence of the Econoliser at that workstation and to a recognition of how the Econoliser needs to be installed and operated. While this protocol has been developed for the comparison of the steriliser with the two-knife Econoliser, it can easily be adopted to other Econoliser equipment sterilisers, e.g. for hock cutters, air knives, etc.

Contents

Cleaning of knives in Australian abattoirs

A longstanding and integral part of the slaughter and dressing process is for operators to clean their knives by rinsing to remove hair, wool and soil before immersing in a water bath maintained no cooler than 82°C. The procedure is done between carcases, between hide-opening cuts on the carcase and as necessary. The baths are known as sterilisers – a misnomer since knife blades are not sterilized *per se*, but rather are 'cleaned' or 'sanitised'; the requirement that water is maintained no cooler than 82°C is rigorously policed by company and regulatory staff.

Scientific underpinning for current knife cleaning requirements

Early work by Empey & Scott (1939) reported treatment in water at 55°C for 5 minutes or 60°C for one minute, with immersion in an alkaline detergent solution for several minutes at 82°C also reported.

Enquiries by CSIRO (Midgley & Eustace, 2003) of their American counterparts elicited firstly that 82°C is the metric equivalent of 180°F and secondly that it may relate to work done in the 1950s at the USDA Agricultural Research Service (ARS) on inactivation of *Mycobacterium tuberculosis*, a primary target pathogen of the period in milk and other foods (Brewer, R. USDA *pers. comm*, March 2002).

While a preference for knife cleaning at 82°C was established, unlike criteria for pasteurisation (72°C for a minimum of 15 seconds or an alternative temperature:time regime which gives an equivalent outcome), the lethal effect of 82°C has never been adequately validated, since no time for delivery of the thermal effect is prescribed. In fact, Peel and Simmons (1978) showed that momentary immersion of knives into water at 82°C was ineffective in totally removing viable salmonellae from knives.

Thus 82°C has become enshrined as the necessary treatment for knife cleaning, together with the installation of the two-knife system (especially for EU Market Access) where the operator uses one knife on the carcase while the other remains in the steriliser, awaiting use on the next carcase/cut.

Effectiveness of knife cleaning

In New Zealand, Bell & Hathaway (1996) measured the effect of knife cleaning at the workstation where opening cuts on the hind legs of lamb carcases are made. Before cleaning, knives had a mean log TVC/cm^2 of 5.04, reflecting the heavy soiling that can occur from the fleece. Rinsing the knife in hand wash water at 44°C removed 98.2% of contamination (1.8 log reduction) from the blade and, after subsequent dipping in 82°C water, a total of 99.8% of contamination was removed, to effect a 2.6 log reduction.

On the beef floor, Bell (1997) found that contamination on knife blades approximated that of the hide on the hind legs (mean log TVC/cm^2 of 3.61). Cleaning the knife by rinsing it in hand wash water and then dipping it in 82°C water reduced the loading on the blade to mean log 2.64/cm^2, a 1 log reduction.

It is notable that the work of Bell & Hathaway (1996) and Bell (1997) illustrated the importance of pre-rinsing the knife – a step which reduced the bacterial loading more than momentary immersion in 82°C water.

International requirements in the USA and EU to "clean and sanitise" equipment between carcases are aligned with Australian requirements set out in paragraph 4.4 of AS 4696:2023:

> *If any part of the premises or any thing:*
>
> *(a) comes into contact with a carcase or carcase part that has not been given a post-mortem disposition; and*

(b) there is a risk it could contaminate a carcase or carcase part intended for human consumption of any other animal; it is cleaned and sanitised before it comes into contact with a carcase or carcase part of any other animal.

Alternatives to cleaning in the steriliser at 82°C

Eustace *et al.* (2008) listed then available alternatives under three headings:

1. Ultrasound and other physical alternatives
2. Chemical alternatives
3. Cleaning in water at temperatures cooler than 82°C.

Increasing energy prices plus shortage of water in Australia's Millennial drought directed research towards alternative three, with several temperature:time regimes being evaluated (Midgley & Eustace, 2003; Eustace *et a*l. 2007, 2008; Goulter *et al*. 2008).

The outcome was a proposal to Meat Standards Committee: "*Water at less than 82°C for sanitising knives and equipment in abattoirs. A guide to gaining regulatory approval."* (MLA, 2007), which was approved by Meat Standards Committee in June 2007.

The Econoliser, a recent alternative knife cleaning system

The Econoliser is a twin-knife machine (Airtech Ltd, Belfast, UK[1]) which sprays in a shearing action over each knife surface, using 140mL per cycle. It has a 500mL tank which heats water rapidly between cycles to >90°C, releasing it at >82°C under pressure onto the knife.

The manufacturers, Airtech Distribution Ltd in Belfast, Northern Ireland claim that knives can be cleaned at least as equivalent to those cleaned in a steriliser, providing the Econoliser is installed and run according to key parameters.

These claims were evaluated in trials at three abattoirs in Australia during 2023-24.

[1] https://econoliser.com/

Evaluation of the Econoliser in Australia, 2023-24

With funds provided by AMPC, the South Australian Research and Development Institute (SARDI) undertook trials at one sheep and two beef plants, with each plant installing two units at stations of their choosing.

After cleaning either via the sterilizer or the Econoliser, the bacterial condition of cleaned knife blades (25 in each system) was assessed by sponging both sides of the blade and measuring populations of residual bacteria (Aerobic Plate Count, APC and *E. coli*). The methodology used followed that presented in Appendix 1 for validating alternate operating parameters of the Econoliser or different units.

Whether equivalence was achieved on knives cleaned in the Econoliser was assessed by a distribution of bacterial counts and statistical analysis comparing the means of the two distributions, taking into account values below the limit of detection. Examples are presented below and distributions for all stations are contained in Appendix 2.

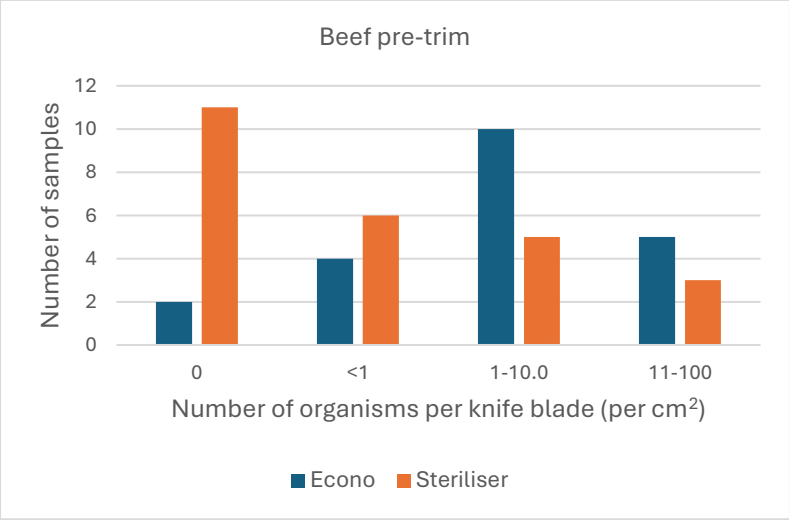

Figure 1: Knives cleaned in the sterilizer had predominantly lower bacterial levels than those cleaned in the Econoliser. As indicated in Table 1, the pressure of hot water supplied to the unit was below the minimum 35psi required.

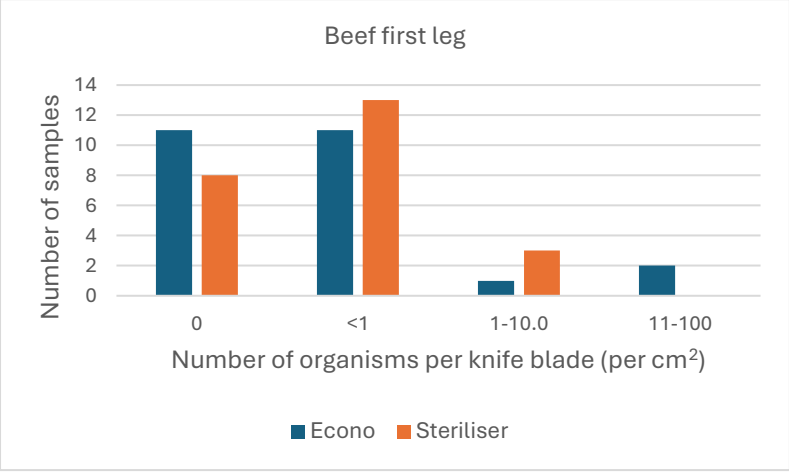

Figure 2: Knives cleaned in the sterilizer and the Econoliser were similarly distributed. As indicated in Table 1, all the required parameters were supplied to the unit and equivalence was achieved.

As may be gained from Table 1, the trials were not universally successful in that equivalence was sometimes not achieved. However, they (the trials) served the purpose of establishing key installation and operating parameters.

Causes of non-equivalence

At the sheep plant, equivalence was not achieved at the on-line stations primarily because:

- The chain speed (9.2 carcases/minute) did not allow sufficient time for the operator to clean the knife using the standard 4.5s Econoliser cycle.
- Reducing cycle time to 3s proved adequate.
- A pressure of only 19psi was available for two evaluations and, when boosted to 35psi, equivalence was achieved.
- High-speed smallstock processing appears difficult at pelt-on stations.

In the beef plant A, equivalence was not achieved because the minimum 35psi pressure could not be supplied to the Econolisers.

Requirements for equivalence

As indicated in Table 1, equivalence can be achieved if the Econoliser is installed at a workstation where the operator has sufficient time to complete all knife cleaning operations and maintain pace with the chain, and that the Econoliser receives:

- Water delivered at >82°C and at least 35psi.
- Pre-rinse to remove soil.
- Cycle time at least 4.5s.

Table 1: Summary statistics of evaluation trials in Australian abattoirs (December 2023, February 2024)

Operation	Location	Equivalence	Spray temperature (°C)	Spray cycle (s)	Spray pressure (psi)	Available time (s)*
Sheep	Y-cut	Yes	>82	4.5	19	6
Sheep	Bung	No	>82	4.5	19	6
Sheep	Y-cut	Yes	>82	3	35	6
Sheep	Retain rail	Yes	>82	4.5	35	na**
Beef (A)	Flanking	Yes	>82	4.5	24	>10
Beef (A)	Pre-trim boning	No	>82	4.5	24	>10
Beef (B)	First leg	Yes	>82	4.5	38	>10
Beef (B)	Bunging	Yes	>82	4.5	38	>10

* Denotes the time the operator was allowed to complete all knife cleaning according to chain speed.

**The operator was not time-limited on the retain rail

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Peel, B. & Simmons, G. 1978. Factors in the spread of salmonellas in meatworks with special reference to contamination of knives. *Aust. Vet. J.* 54:106–110.

Appendix 1: Protocol for verifying microbiological equivalence if parameters are changed

If a change to Econoliser parameters, other than those associated with equivalence as presented in Appendix 2, is made it will be necessary to undertake a full validation study, along the following lines. This protocol can be adapted to validate Econolisers for different equipment, such as air knives or hock cutters.

Study design

Compare contamination levels on knives after they have been cleaned by rinsing and dipping in 82°C water with those on knives cleaned by rinsing and placing in an Econoliser Twin Knife Steriliser.

The number of knife replicates for both systems should be 20-30 and testing should be carried out on at least two occasions e.g. 12-13 knives for each system in the morning and afternoon or 5 knives for each system on each of 5 days.

Make a note of the cleanliness of stock on which knives are being used and identify the workstation.

Current knife use and cleaning method

The operator is required to align with work instructions for the tasks of the operation. After use, the knife is rinsed under warm water and placed in the 82°C water bath until required.

Knife use and Econoliser cleaning

The operator aligns with work instructions as above except that, on completion of rinsing, the knife is placed in the Econoliser unit and the spray is activated. It is important to ensure that the knife remains in the Econoliser for the full duration of the spray (default 4.5s).

Sponge sampling of knives

This is best carried out by two people, one of whom presents the sterile sponge ready for use by the sponger, who must have a sterile gloved hand to use the sponge.

The blade of the cleaned knife is sampled immediately before its use by the operator (i.e. after it has received its cleaning cycle) by drawing a sterile sponge (e.g. Nasco Whirlpak) hydrated in Butterfields solution over both surfaces of the blade from handle to tip.

The sponger then returns the used sponge to the Whirlpak bag held open by the colleague.

Transportation of samples to the laboratory

After sampling, sponges in sterile bags are processed either onsite for immediate testing or sent to an offsite laboratory in a manner similar to that for ESAM testing.

Determination of Aerobic Plate Count (APC) and *E. coli*

At the laboratory, to liberate bacteria the sponge is squeezed firmly and multiple times (“squishing”) through the plastic bag for 30s and, from the moisture expressed, serial dilutions prepared in 0.1% buffered peptone water blanks (9 mL) using 1mL aliquots.

Aliquots (1mL) from each dilution are spread on either Aerobic Plate Count Petrifilm (3M) or *E. coli* Petrifilm (3M) and incubated at 30°C for 48 hours and 35°C for 48 hours, respectively. Colonies are identified and counted as colony forming units (CFU) as per the manufacturer’s instructions.

To enable counts to be expressed in terms of cfu/cm^2 of blade, the area of each knife is calculated by tracing the outline of the blade on graph paper (5 mm squares), summing the squares (or parts thereof as best as possible) and multiplying the result by the area of each square (0.25 mm^2).

When no bacteria are recovered from a knife blade, the result is recorded as "not detected" for *E. coli* and as the limit of detection for APC (for the purpose of data analysis).

The count/cm^2 of APC and *E. coli* is calculated as: Count on Petrifilm × $10^{dilution}$ × 25 mL / area of knife blade.

The limit of detection is calculated as: 1 × $10^{dilution}$ × 25 mL/area of knife blade.

Example 1: The area of a knife blade was estimated to be 92 cm^2. There were 2 colonies counted on the neat Petrifilm i.e. dilution equals 0. Consequently, the number of cells in the sample bag equals $2\times10^0\times25$ = 50 cells and these came from 92 cm^2 of knife blade, giving a concentration of 50/92 = 0.54 cfu/cm^2.

Example 2: The area of a knife blade was estimated to be 125 cm^2. There were 5 colonies counted on the Petrifilm of the first serial dilution i.e. dilution equals 1. Consequently, the number of cells in the sample bag equals $5\times10^1\times25 = 5\times10\times25$ = 1250 cells and these came from 125 cm^2 of knife blade, giving a concentration of 1250/125 = 10 cfu/cm^2.

Statistical analysis

For the evaluation of equivalence of the two systems, the statistical tests demonstrated in MLA's "Processor's Guide to Improving Microbiological Quality and Shelf Life of Meat" 3rd Edition and the associated "Testing template v7.xlsx" can be used.[2]

For *E. coli* detection, the "Two proportions" test can be used, while for APC, the "Two independent groups" test can be used on the $\log_{10}$ transformed APC counts,[3] where values below the limit of detection ("<LOD") are replaced by the corresponding LOD[4]. In both cases, a "not significant" result indicates that the two knife sterilisation systems are equivalent in relation to the corresponding microorganism.

Alternatively, for APC, a censored regression approach[5] can be used, which better takes into account values below the limit of detection. For assistance with this approach, please contact Andreas Kiermeier (andreas.kiermeier@gmail.com).

[2] Available from Andreas Kiermeier (andreas.kiermeier@gmail.com)
[3] The log transformation and statistical comparison is taken care of automatically.
[4] For example, a value of "<0.01" is entered into the Excel tool as "0.01".
[5] Lorimer, M.F. & Kiermeier, A. 2007. Analysing microbiological data: Tobit or not Tobit? International Journal of Food Microbiology, 116(3): 313–318.

Appendix 2: Assessment of microbiological equivalence at eight workstations in Australian abattoirs

The following sections provide a summary of the results obtained from the Econoliser trials undertaken as part of the 2023-24 evaluations funded by AMPC. In all cases, the comparison of APC (number of organisms per cm^2 of knife blade) was performed using a censored regression approach and *E. coli* detections were assessed using a two-sample test for proportions.

Sheep Y-cut 1

The line ran at 9.2 head/minute allowing 6s to perform all tasks per carcase. The knife had 4-5s in the steriliser. For the Econoliser assessment, a 3-knife system was used to not slow the operator and allow for pre-rinsing of knife to get rid of wool prior to insertion into the Econoliser, which was provided with only 19psi water pressure.

The distribution of APC is shown in Figure 3**Error! Reference source not found.** and a summary of the results is provided in Table 2. Based on the statistical analysis, there was equivalence between the steriliser and Econoliser for *E. coli* (P-value = 1) and for APC (P-value = 0.66).

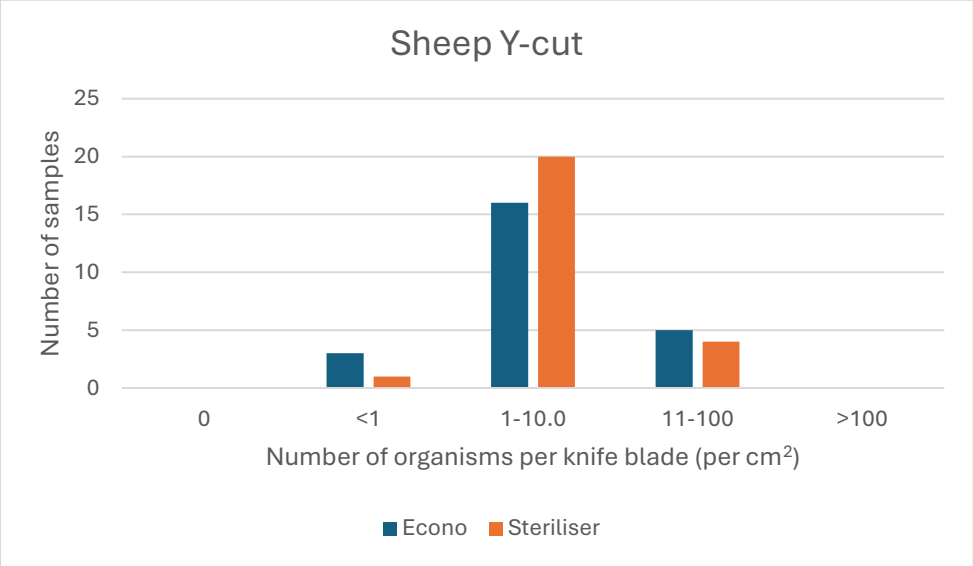

Figure 3: Distribution of APC per cm^2 of knife blade collected at the Y-cut.

Table 2: Summary of results (APC are reported as cfu/cm^2) collected at the Y-cut.

Equipment	N	% APC detected	Mean log_{10} APC*	Mean APC**	% E. coli detected
Steriliser	25	100	0.57	3.72	0
Econoliser	24	100	0.51	3.26	0

* Estimated from the model, taking non-detects into account.

** Geometric mean, on the arithmetic scale, obtained by exponentiating the estimated "Mean log_{10} APC".

Sheep Bunging

The line ran at 9.2 head/minute allowing 6s to perform all tasks per carcase. The knife had 4-5s in the steriliser. For the Econoliser assessment, a 3-knife system was used to not slow the operator and allow for pre-rinsing of knife. The Econoliser was provided with only 19psi water pressure.

The distribution of APC is shown in Figure 4 and a summary of the results is provided in Table 3. Based on the statistical analysis, there was no equivalence between the steriliser and Econoliser for *E. coli* (P-value = 0.007) and for APC (P-value < 0.001).

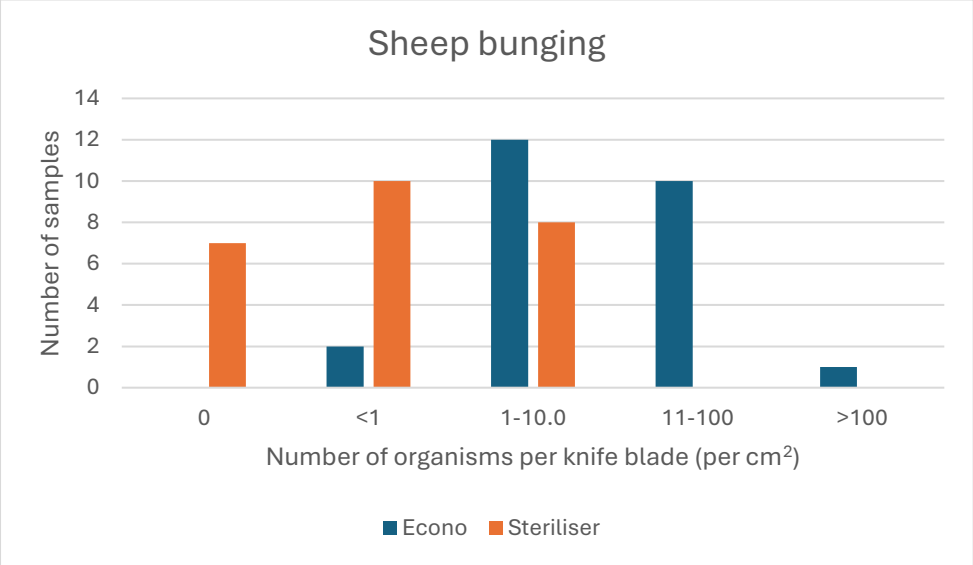

Figure 4: Distribution of APC per cm² of knife blade collected at the bunging station.

Table 3: Summary of results (APC are reported as cfu/cm²) collected at the bunging station.

Equipment	N	% APC detected	Mean log_{10} APC*	Mean APC**	% E. coli detected
Steriliser	25	72	-0.33	0.47	0
Econoliser	25	100	0.86	7.23	32

* Estimated from the model, taking non-detects into account.

** Geometric mean, on the arithmetic scale, obtained by exponentiating the estimated "Mean log_{10} APC".

Sheep Y-cut 2

The line ran at 9.2 head/minute allowing 6s to perform all tasks per carcase. The knife had 4-5s in the steriliser. For the Econoliser assessment, the spray time was reduced to 3s which allowed for the operator's pre-rinsing of the knife to get rid of wool prior to insertion into the Econoliser, which was provided with 35psi water pressure.

The distribution of APC is shown in Figure 5 and a summary of the results is provided in Table 4. Based on the statistical analysis, there was equivalence between the steriliser and Econoliser for *E. coli* (P-value = 0.12) and better than equivalence for APC (P-value < 0.001).

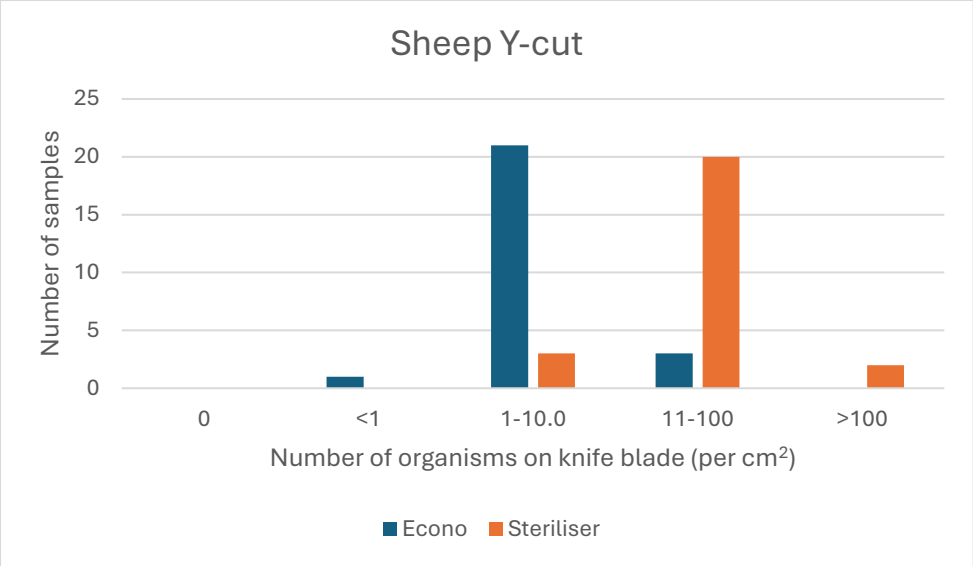

Figure 5: Distribution of APC per cm² of knife blade collected at the Y-cut.

Table 4: Summary of results (APC are reported as cfu/cm²) collected at the Y-cut.

Equipment	n	% APC detected	Mean log_{10} APC*	Mean APC**	% E. coli detected
Steriliser	25	100	1.30	19.9	4
Econoliser	25	100	0.57	3.8	0

* Estimated from the model, taking non-detects into account.

** Geometric mean, on the arithmetic scale, obtained by exponentiating the estimated "Mean log_{10} APC".

Sheep Retain rail

The line speed was not relevant on the retain rail. The operator used only a single knife (and a hook) which he rinsed prior to either momentarily dipping the knife into the sterilizer or inserting it into the Econoliser and waiting until the spray duration was complete. The Econoliser was provided with 35psi water pressure.

The distribution of APC is shown in **Error! Reference source not found.** and a summary of the results is provided in Table 5. Based on the statistical analysis, there was equivalence between the steriliser and Econoliser for *E. coli* (P-value = 0.12) and better than equivalence for APC (P-value = 0.001).

Figure 6: Distribution of APC per cm² of knife blade collected at the retain rail.

Table 5: Summary of results (APC are reported as cfu/cm²) collected at the retain rail.

Equipment	N	% APC detected	Mean log_{10} APC*	Mean APC**	% E. coli detected
Steriliser	25	100	0.47	2.9	0
Econoliser	25	64	-0.11	0.7	4

* Estimated from the model, taking non-detects into account.

** Geometric mean, on the arithmetic scale, obtained by exponentiating the estimated "Mean log_{10} APC".

Beef Flanking

The line ran at 1.5 head/minute allowing 40s to perform all tasks per carcase, which included clearing of the hide with the knife, rinsing the knife and placing it in the sterilizer, clearing more hide with an air knife and finally washing the operator's hands between carcases. The knife had over 20s in the sterilizer. The Econoliser was provided with 24psi water pressure.

The distribution of APC is shown in **Error! Reference source not found.** and a summary of the results is provided in Table 6. Based on the statistical analysis, there was equivalence between the steriliser and Econoliser for *E. coli* (P-value = 1) and for APC (P-value = 0.35), despite the low water pressure.

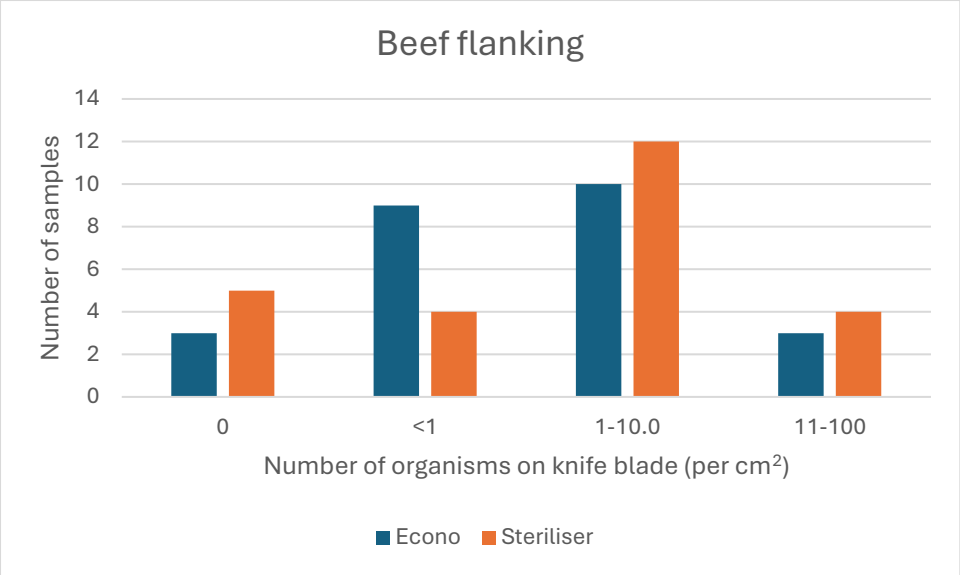

Figure 7: Distribution of APC per cm² of knife blade collected at the flanking stand.

Table 6: Summary of results (APC are reported as cfu/cm²) collected at the flanking stand.

Equipment	N	% APC detected	Mean log_{10} APC*	Mean APC**	% E. coli detected
Steriliser	25	80	0.32	2.1	0
Econoliser	25	88	0.16	1.5	0

* Estimated from the model, taking non-detects into account.

** Geometric mean, on the arithmetic scale, obtained by exponentiating the estimated "Mean log_{10} APC".

Beef Pre-trim boning

The line ran at 2.5 sides/minute allowing 24s to perform all tasks per carcase. The knife had over 15s in the steriliser. The Econoliser was provided with 24psi water pressure.

The distribution of APC is shown in **Error! Reference source not found.** and a summary of the results is provided in Table 7. Based on the statistical analysis, there was equivalence between the steriliser and Econoliser for *E. coli* (P-value = 1) but not for APC (P-value = 0.007).

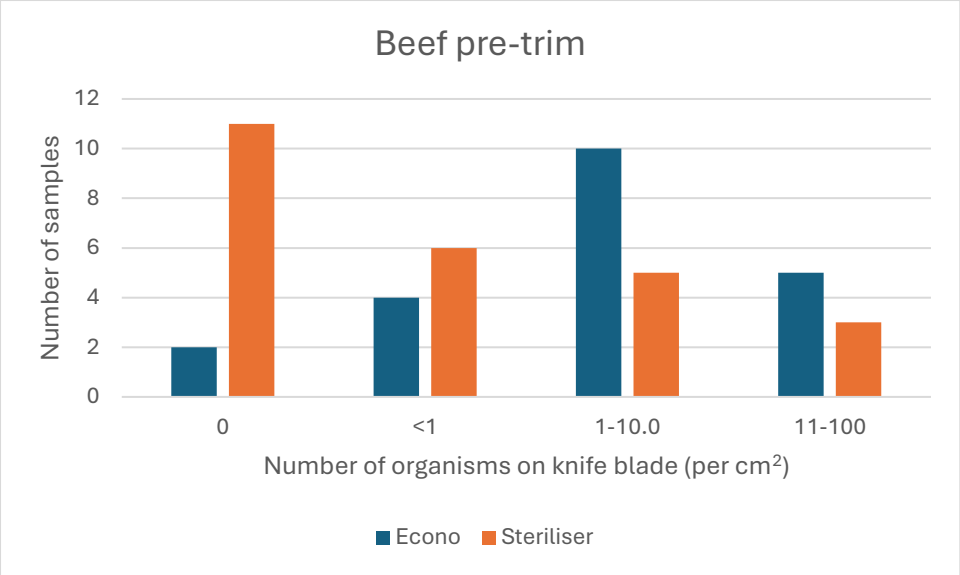

Figure 8: Distribution of APC per cm² of knife blade collected at the boning room pre-trim.

Table 7: Summary of results (APC are reported as cfu/cm²) collected at the boning room pre-trim.

Equipment	n	% APC detected	Mean log_{10} APC*	Mean APC**	% E. coli detected
Steriliser	25	56	-0.16	0.69	0
Econoliser	21***	90.5	0.45	2.81	0

* Estimated from the model, taking non-detects into account.

** Geometric mean, on the arithmetic scale, obtained by exponentiating the estimated "Mean log_{10} APC".

*** Four samples were excluded due to technical problems during sample collection.

Beef First leg

The line ran at 2 head/minute allowing 30s to perform all tasks per carcase, which included clearing of the hide in several areas around the leg with the knife, rinsing the knife and placing it in the steriliser. The knife had over 15s in the sterilizer. The Econoliser was provided with 38psi water pressure.

The distribution of APC is shown in **Error! Reference source not found.** and a summary of the results is provided in Table 8. Based on the statistical analysis, there was equivalence between the steriliser and Econoliser for *E. coli* (P-value = 1) and for APC (P-value = 0.68).

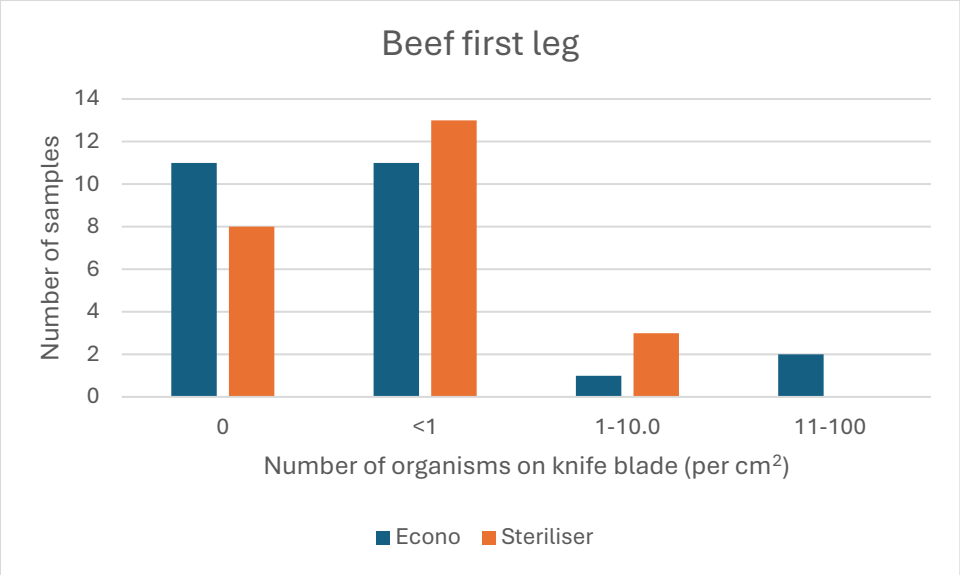

Figure 9: Distribution of APC per cm² of knife blade collected at the first leg station.

Table 8: Summary of results (APC are reported as cfu/cm²) collected at the first leg station.

Equipment	n	% APC detected	Mean log_{10} APC*	Mean APC**	% E. coli detected
Steriliser	25	68	-0.48	0.33	0
Econoliser	25	56	-0.56	0.28	0

* Estimated from the model, taking non-detects into account.

** Geometric mean, on the arithmetic scale, obtained by exponentiating the estimated "Mean log_{10} APC".

Beef Bunging

The line ran at 2 head/minute allowing 30s to perform all tasks per carcase, which included clearing around the bung, placing a rubber band over the operator's hand, which was inserted into a plastic bag and inverted over the bung and secured with the rubber band, and finally pushed inside the cavity. The knife had over 15s in the sterilizer and the Econoliser was provided with 38psi water pressure.

The distribution of APC is shown in **Error! Reference source not found.** and a summary of the results is provided in Table 9. Based on the statistical analysis, there was equivalence between the steriliser and Econoliser for *E. coli* (P-value = 1) and for APC (P-value = 0.21).

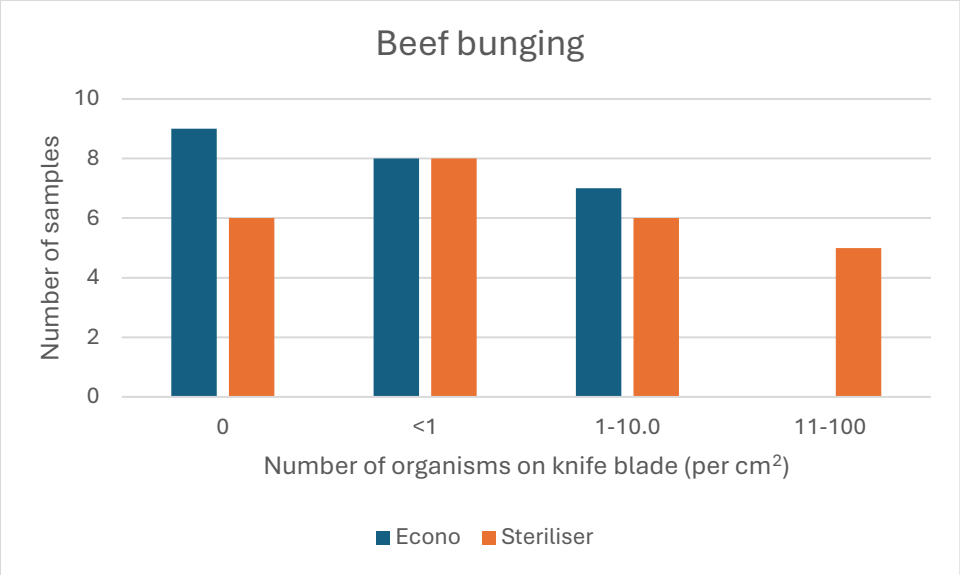

Figure 10: Distribution of APC per cm² of knife blade collected at the bunging station.

Table 9: Summary of results (APC are reported as cfu/cm²) collected at the bunging station.

Equipment	n	% APC detected	Mean log_{10} APC*	Mean APC**	% E. coli detected
Steriliser	25	76	-0.06	0.87	0
Econoliser	25	64	-0.40	0.40	0

* Estimated from the model, taking non-detects into account.

** Geometric mean, on the arithmetic scale, obtained by exponentiating the estimated "Mean log_{10} APC".

Appendix 3: Checklists for verifying that an Econoliser has been installed so that effective knife cleaning can occur

The following checklists may be used by DAFF and establishment staff both following installation and as part of MHA: Process Monitoring.

Verification at installation

Criterion	Minimum acceptable value	Assessment method	Minimum acceptable value achieved?	
			Yes	No
Satisfactory time to complete cleaning	Specific to station	Visual		
Temperature at display*	>86°C	Visual		
Temperature of spray water	82°C	Econoliser Calibrated Digital Thermometer and special probe (Part: 305P-PRB300-003)**		
Pressure of sprays	35 psi	Econoliser pressure test manifold with gauge (Part: ECSP004)**		
Duration of spray	4.5s	Stopwatch		
Decision	Econoliser is/is not set up correctly			

* Where installed

** Available from Airtech Distribution Ltd

Notes:

1. Airtech Ltd does not recommend the use of a tip sensitive digital thermometer due to the wide spray angle and limited contact time which does not allow the thermometer to determine an accurate temperature reading, i.e. temperature obtained this way is usually lower than 82°C.
2. The digital temperature display (where installed) uses a probe in the pipework between the tank and spray nozzles which provides a real-time display of the water temperature at this point. However, Airtech Ltd states that this probe is not calibrated and hence needs to be checked against the Econoliser Calibrated Digital Thermometer and special probe on a regular basis.

Verification at MHA: Process Monitoring

Station	Location	Date	Time	Display (°C)	Spray (°C)	Pressure (psi)	Duration (s)	Comment
1	Sticking							
2	Weasand clearing							
3	First leg							
4	Second leg							
5								
6								
7								
8								
9								