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Validation of an alternative procedure for knfe cleaning on the slaughter floor

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OPINION ON APPLICATION BY M C HERD PTY LTD

M. C. Herd Pty Ltd has submitted an application to the Meat Standards Committee for approval to adopt an alternative regime based on experimental work done at the plant in 2004-05. This regime involved two knives where the operator exchanged knives between carcases. The knives were washed in hand-wash water, then immersed in water at 60°C for the time it took the operator to complete the specific operation with the other knives.

Test results submitted with the application indicate that use of the two-knife system where each knife is washed under running hand-wash water then given the 60°C treatment is equivalent to the current 82°C regime used by the applicant.

Based on the results of investigations undertaken at M C Herd, it is concluded that the proposed regime will maintain knives in sanitary condition and will not compromise the safety of the carcase and meat parts on which they are used and thereby meet the requirements of AS 4696:2002. It is recommended that the Committee support approval of the application from M C Herd to implement the proposed alternative procedure for cleaning knives between carcases on the beef and mutton slaughter floors.

It is our opinion that the Committee should also endorse approvals of other applications to controlling authorities to use procedures that do not involve 82°C water on the condition that applicants either:

- Nominate an alternative procedure with conditions for which there are published data that confirm their microbiological effectiveness; or
- Demonstrate that the alternative procedure delivers an equivalent or superior outcome to the procedure currently used.

REVIEW OF PUBLISHED LITERATURE

EXECUTIVE SUMMARY

Knife and equipment sterilisers that operate at not less than 82°C use large volumes of hot water, creating water supply and disposal problems, high-energy costs and operator safety concerns for Australian meat processors. Neither the need for nor the superiority of 82°C water is supported by published scientific information.

An application has been made to the Meat Standards Committee to adopt an alternative regime for treating knives and other equipment on beef and small-stock slaughter floors. Such applications are allowed for in Australian Standard AS 4696-2002. The several benefits mentioned above would apply to most abattoirs if approval is given and the demand for 82°C water can be reduced.

The present document reviews current regulatory requirements, the historical reasons for using 82°C water, and relevant scientific literature on 82°C water and water at lower temperatures for cleaning and sanitising knives and equipment during processing operations.

The reason why 82°C became the prescribed minimum temperature for treating knives and equipment is unclear because food microbiology texts provide various long-used temperatures and corresponding minimum contact times for the internationally validated processes of cooking, pasteurisation and sterilisation, none of which makes reference to 82°C. The containers of 82°C water for treating knives have long been termed 'sterilisers' but immersion of knives for brief (1 s or less), even up to some minutes, clearly does not comply with the scientific meaning of sterilisation.

The available evidence suggests that washing knives makes a greater contribution to maintaining the knives and equipment in a clean and sanitary condition during processing than does their brief immersion in 82°C water.

The applicant M C Herd Pty Ltd compared two regimes:-

- the current one where the knives were washed in hand-wash at 20-40°C followed by momentary dipping in water at 82°C; with
- an alternative regime where the system employed was a two knife one where the operator exchanged knives between carcases. The knives were washed in hand-wash water then immersed in water at 60°C for the time it took the operator to complete the specific operation with the other knife.

On the beef floor the mean log TVC on 230 knives (10 from each of 23 task stations) was 2.20 after the current regime, 1.78 after the alternative regime. *E. coli* was detected on 20 and 21 (of the 230 in each treatment group) knives respectively.

On the mutton floor the mean log TVC on 130 knives (10 from each of 13 task stations) was 1.87 after the current regime and 1.69 after the alternative one. *E. coli* was detected on 24 and 29 (of the 130 in each treatment group) knives respectively.

Based on the results from that investigation, it may be concluded that the proposed regime will maintain knives in sanitary condition and will not compromise the safety of the carcase and meat parts on which they are used, thereby meeting the requirement of AS 4696-2002 and the Export Control (Meat and Meat Products) Orders. The proposed regime is also consistent with the requirements of the Food Standards Code.

Equivalence of current and alternative procedures by demonstrating in-plant that the alternative procedure does not result in numbers of bacteria that are higher than the current procedure, as M C Herd has done, is the most practical, and one that will probably be adopted by other applicants.

M C Herd supplied data from a large number of test results. In future cases where validations are made the numbers of tests can probably be reduced. The actual numbers of tests required will depend on the variability evident in the data but will probably be 30 to 50.

INTRODUCTION

Since the 1960s there have been regulatory requirements in many countries for the use of hot water at not less than 82°C (180°F) for disinfection of knives and other implements used during slaughter and dressing operations. All Australian red meat establishments have been required to have available at all times, water at a minimum of 82°C, the belief of regulators being that unless the knives and other implements are disinfected this way they become sources of microbiological contamination.. The water is required for knife sterilisers, sterilisers for carcase splitting saws, hock cutters, brisket shears and other large items, and for viscera tables.

Recent amendments to guidelines, standards or regulations in several countries, including Australia, are reviewed below. The amendments mean that regulators will now consider alternatives to water at 82°C if they can be demonstrated to be at least as effective and reliable as brief contact with the 82°C water.

The potential benefits of using disinfection treatments other than the current requirement of 82°C include:

- Reduced risk of operator injury (scalds etc);
- Reduced hot water consumption, particularly by knife and equipment sterilisers;
- Less water, particularly hot water, going to effluent ponds;
- Savings in energy costs for heating and reduced greenhouse gas emissions;
- Reduced fogging and condensation; and
- Probable reductions in maintenance requirements and processing 'down time'..

The purpose of this review is to :

1. Trace the origins and historical reasons for using 82°C water for sterilising,
2. Outline the current regulatory requirements and guidelines,
3. Outline current industry practice in Australia, New Zealand, US and elsewhere for 'sterilising', and
4. Provide details of relevant scientific investigations,
5. Compare data provided by the applicant with published information, and
6. Make recommendations on determination of equivalence of alternative procedures for cleaning during processing.

Origins of 82 °C/180 °F requirement

There does not appear to be a scientific basis for the historical international focus on 82°C/180°F as a disinfection temperature in abattoirs. While such temperatures as 65°C (cooking), 72°C (pasteurisation), and 121°C (sterilisation, eg. canning) and the corresponding treatment times are frequently specified in food microbiology texts (eg. Jay, 1996), no reason is given in meat hygiene texts for specifying water of 82°C/180°F and no corresponding treatment time is provided.

The origins of 82°C/180°F as the required temperature are unclear. The first mention of the use of 82°C water appears to be by Australian researchers. Empey and Scott (1939) described a number of measures that were introduced in the 1930s to reduce the level of microbial contamination on beef carcases that were shipped chilled to Great Britain. One of the measures was to replace saws and cleavers after their use on 12 carcases with duplicates which had been held during the intervening period in alkaline detergent solution at approximately 82°C and rinsed in cold water before use. Knives and steels were not treated the same way. After they had been used for a group of 12 carcases they (and the hands and arms of operatives) were immersed in alkali and then sprayed with warm water. The temperature of the alkali was not stated but presumably it was at ambient temperature. These authors and another Australian author, Collins (1966), suggested that water used for washing beef should be heated to 140°F for one minute or to 130°F for 5 minutes. Collins stated that knives and saws should be replaced after twelve carcases and subjected to immersion in alkali at 160-180°F.

Collins (1966) wrote that under commercial conditions it sufficed to cleanse knives of inspectors and butchers by immersing the blade in boiling water until all grease is removed, an action facilitated if detergents were added. The action was not considered a sterilisation, but rather a removal of the bacteria-laden grease. He stated that because they were frequently making incisions, inspectors should frequently clean their knives and for this purpose, suitable "sterilisers" containing boiling water should be provided.

Past and present staff at the United States Department of Agriculture have provided a number of opinions on the US origins of the 82°C water requirement (R Brewer, USDA personal communication, 2002). In the 1950s a Dr Sloan, working for the USDA Agricultural Research Service (ARS) in Beltsville, Maryland, is believed to have investigated methods of sterilising carcass-splitting saws. Sloan found that dipping the carcass splitting saws in 180°F water effectively killed sufficient numbers of organisms to satisfy regulatory requirements. Eventually 180°F water became a requirement for all slaughter floor operations.

An alternative explanation provided by USDA was that the 180°F requirement was based on the heat resistance of the zoonotic pathogen *Mycobacterium tuberculosis* (R Brewer, personal. communication) which was a widespread concern in the 1950s. Water at 180°F may have been chosen as the knife sterilisation procedure that would kill the tubercule microorganism, the primary target organism in meat, milk and other foods at that time.

Regulatory position in Australia and overseas

Regulatory Standards

<u>Australia</u>

The **Australian Standard** for the hygienic production and transportation of meat and meat products for human consumption (AS 4696-2002) requires that:
'the facilities for cleaning and sanitising implements .....
(c) are provided with an adequate supply of hot potable water at no less than 82°C or an equivalent method of sanitising' (clause 20.5)

In the **Export Meat Orders 1985**, EMO 103.1 states that in the case of water used for sterilization by immersion or spray, the water shall be maintained at a temperature of not less than 82°C. In the **Export Control (Meat and Meat Products) Orders, 2005**, scheduled for implementation in July 2005, Order 32.1 states that meat and meat products for export for food must be prepared at an establishment where the premises, equipment, facilities and essential services comply with the applicable requirements of the Australian Meat Standard, AS 4696-2002. In the Orders, 'facilities' as defined, include hygiene and sanitation facilities.
Therefore, the Orders require that cleaning and sanitizing implements be done in accordance with AS 4696.

Australia New Zealand Food Standards Code

The requirements of Standard 3.2.2, clause 20 are:

> In subclause (1), a 'clean and sanitary condition' means, in relation to a surface or utensil, the condition of a surface or utensil where it -
>
> (a) is clean; and
>
> (b) has had applied to it heat or chemicals, heat and chemicals, or other processes, so that the number of micro-organisms on the surface or utensil has been reduced to a level that:
>
> (i) does not compromise the safety of the food with which it may come into contact; and
>
> (ii) does not permit the transmission of infectious disease.

Applied to knife and equipment sanitation in meat processing, this clause allows several options for treating knives and equipment as long as the safety of meat is not compromised and does not allow the transfer of pathogens to the meat.

European Community

The European Commission Council Directive 64/433/EEC requires that meat-producing and meat-processing establishments must have facilities for disinfecting tools with hot water supplied at not less than 82°C. This is reflected in the current requirements of Community member countries.

In June 2001, the European Commission's Scientific Committee on Veterinary Measures relating to Public Health (SCVPH) adopted an opinion paper entitled 'The cleaning and disinfection of knives in the meat and poultry industry'. Inter alia, SCVPH concluded that using water at 82°C or higher is not fully effective in the absence of cleaning and that use of water at lower temperatures with lactic acid or other agents can be used as a satisfactory alternative to the currently approved procedure.

Regulation (EC) number 853/2004 of the European Parliament and of the Council laying down specific hygiene rules for food of animal origin was passed in April 2004, published in the Official Journal of the European Union, and is scheduled to take effect in member countries early in 2006. The regulation states that slaughterhouses and cutting plants must have facilities for disinfecting tools with hot water supplied at **not less than 82°C, or an alternative system having an equivalent effect.**

United States of America

In its Final Rule on Sanitation Requirements for Meat and Poultry Establishments, date of effect 25 January 2000, the USDA Food Safety and Inspection Service rescinded - in Title 9, Code of Federal Regulations, Part 416.3 - the previous requirement for use of 180°F (82°C) to disinfect utensils and equipment used to dress diseased meat carcases. While accepting that many meat establishments will continue using 180°F water for this purpose, USDA recognised that others will use different means. Establishments that want to innovate **may do so if they can maintain sanitary conditions and prevent adulteration of product.**

Codex Alimentarius Commission Code of Hygienic Practice

The Codex Committee on Meat Hygiene continues to elaborate a Code of Hygienic Practice for Meat (currently at step 8 of the Codex Alimentarius process). The Draft Code stipulates that:

> 164. Particular cleaning programmes are required for equipment used in the slaughter and dressing of carcasses e.g., knives, saws, machine cutters, evisceration machines and flushing nozzles.

> Such equipment should be:
> • clean and sanitised before each new period of work;
> • cleaned, and sanitised, by **immersion in hot water or alternative methods, with appropriate frequency** during and/or between periods of work;
> • immediately cleaned and sanitised when coming into contact with abnormal or diseased tissue that may harbour food-borne pathogens; and
> • stored in designated areas in such a manner that it will not become contaminated.

It can be seen that Codex and the current or imminent requirements of several counties, including Australia, state that alternative methods to 82°C water may be used provided that they can be demonstrated to maintain sanitary conditions at least as well as 82°C water can.

In Australia and New Zealand, knives must be cleaned and sanitised between carcases and where hide or pelt opening cuts are followed by clearing cuts on a particular carcase, between successive cuts. In the US, utensils and equipment "... must be cleaned and sanitized as frequently as necessary to prevent creation of insanitary conditions and the adulteration of product". It is known that some US slaughter plants do not treat knives after every carcase. In the EU there is a requirement that equipment coming into contact with the outer surface of a hide or fleece must not touch the meat. This effectively means that knives used for opening cuts must be cleaned between tasks and carcases..

How effective is 82 °C water?

There appears to be no clear scientific basis for the historical international focus on 82°C/180°F as a disinfection temperature in abattoirs. There are data to show that brief exposure to a temperature of 82°C in a fluid medium is effective as is demonstrated for *Listeria* and *Salmonella* by data from Doyle and Mazzotta (2000) and Doyle et al. (2001) where at 82°C a treatment time of less than one second resulted in 5-log reductions of the bacteria.

However, momentary exposure of knives and equipment to 82°C is not sufficient to ensure a significant bactericidal effect. Thermal inertia of the equipment will prevent surfaces attaining the water temperature until several seconds have elapsed (Lowry, 1991). In studies in meatworks, Peel and Simmons (1978) showed that treatment of knives at 82°C was ineffective in decontaminating knives of viable salmonellas, in their opinion probably because the knives were dipped only momentarily by the operatives. They found that 10 of 21 (48%) hide-opening knives sampled after 82°C treatment were contaminated with Salmonella compared with 12 (57%) after cutting the hide but before the 82°C water. In laboratory studies on knives they found that salmonellas survived after exposure of artificially contaminated knives to 82°C water for at least 4 seconds but did not survive after exposure for 8 seconds.

Other studies have shown that knives carry residual bacteria after treatment at 82°C. New Zealand data are available for knives after they had been subjected to 82°C water in plants lambs processing (Bell and Hathaway, 1996) and cattle (Bell 1997). After a 44°C spray rinse and 82°C water treatment, blades of knives used to make opening hind leg cuts on a conventional lamb dressing line had mean log total counts of 2.42 (263) per cm^2. For knives used in the cattle plant for hind leg opening cuts, the log mean total count after a rinse and 82°C treatment between carcases was 2.64 (437) per cm^2. Lowry (1991) reported on a New Zealand study done at an export lamb plant that investigated the effect of an 82°C wash on the microbial loading of two items of equipment – a roller scalper and viscera collection trays. The study also included two other wash treatments – cold water (22°C) only and 43°C water. For all three treatments, total counts were mostly between 100 and 1000 cfu per cm^2 and coliforms were mostly below 10 cfu per cm^2.

Thiaudiere (1992, 1994) reported on laboratory and industry studies of knife cleaning in France. After immersion for one minute in 82°C water, knives had a mean log total count of 2.98 (955).

The reductions reported by Bell and Hathaway (1996), Bell (1997) and Thiaudiere (1992) in total counts of bacteria were, in log units, 2.6, 1.0 and 1.4 respectively.

From these published studies it can be concluded that once they have been subjected to immersion in 82°C water, many knives will have total counts between 100 and 1,000 per cm^2 and they may have low numbers of coliforms. The data of Midgley and Eustace (2003) and the data of the applicant agree with the published findings.

The efficacy of brief immersion of knives into 82°C water is affected by any soil on them. Hot water at 82°C was found to affix proteins onto the surface of the equipment (Weise and Levetzow, 1976; Schütt-Abraham *et al.*, 1988), leading to possible entrapment of bacteria and cleaning difficulties. Snijders *et al* (1985) found that when fats or proteins were present on a stainless steel plate, immersion at 82°C for as long as 10 seconds did not give satisfactory reductions in bacterial contamination.

Demonstrating equivalence of treatments for knives

There are many data that compare the lethality of different times and temperatures against bacteria suspended in fluids. Some for *Salmonella* are summarised below (Table 1). Whereas the table shows that good reductions of salmonellae occur after very brief times of treatment (less than 0.5 s at 78-82°C) when the salmonellae are in a fluid matrix, the data of Peel and Simmonds (1978) and Snijders et al (1985) show that when the cells are on knives or equipment surfaces, the very brief treatment times are inadequate. As stated already, the thermal inertia and high conductivity of the metal knives and equipment mean that surfaces will take several seconds to attain the water temperature.

In the table, the contact times (and the corresponding temperatures) greater than 15 seconds are likely to be of relevance for knives because there is time for the surfaces to warm to near the water temperature. Said another way, treatments that are shown to be equivalent in Table 1 to a brief (<5 s) treatment at 82°C would probably be superior to that brief treatment when applied to knives or other equipment.

Table1. Times in seconds for specified reductions in *Salmonella*
(From equation of Doyle and Mazzotta, 2000; log D-value = 11.7 -0.188T°C, calculated from data for food products including milk, liquid egg, ground beef).

Temperature (°C)	Time (s)		
	1 log unit (1D)	2 log units (2D)	3 log units (3D)
60	158	316	473
61	102	205	307
62	66	133	199
63	43	86	129
64	28.0	56	84
65	18.1	36	54
66	11.8	23.5	35
67	7.6	15.2	22.8
68	4.9	9.9	14.8
69	3.2	6.4	9.6
70	2.1	4.2	6.2
71	1.3	2.7	4.1
72	0.9	1.7	2.6
73	0.6	1.1	1.7
74	<0.5	0.7	1.1
75	<0.5	0.5	0.7
76	<0.5	<0.5	0.5
78	<0.5	<0.5	<0.5
80	<0.5	<0.5	<0.5
82	<0.5	<0.5	<0.5

In addition to using published equivalence data such as those summarised in Table 1, there are two possible approaches to demonstrating equivalence of treatments for knives and equipment:

1. Demonstrate that the numbers of test bacteria applied deliberately to test knives (in an off-plant situation) are reduced by at least the same extent by the alternative procedure as achieved at 82°C; or
2. Demonstrate in-plant that the alternative procedure does not lead to the creation of insanitary conditions and the adulteration of product –best done by demonstrating that the procedure does not result in bacterial numbers on knives that are higher than found after treatment at 82°C.

Alternative procedures for inactivation of bacteria - temperatures lower than 82 °C

Published studies

Peel and Simmons (1978) investigated the survival of *Salmonella* typhimurium on knives contaminated with mince meat and immersed for up to 20 s in water at 75°, 82°, or 90°C. Immersion for 8 s at 82°C led to elimination of *S.* typhimurium from all knives tested but not in water at 75°C; immersion for 12 s or longer at 75°C eliminated the organism.

Snijders *et al* (1985) used stainless steel plates smeared with freshly slaughtered cheek meat deliberately contaminated with *E. coli* to investigate immersion treatments that included immersion for 5 or 15 s in water at 60 or 82°C. At 82°C reductions in numbers of *E. coli* were 2.3 and 2.2 log units after 5 and 15 s respectively. At 60°C the reductions after 5 and 15 s were 0.7 and 1.0 log units. Thiaudiere (1992, 1994) investigated water at 60° or 82°C, treatment times of 15, 30, or 60 s, and soaking or spraying for disinfecting knives. He found that when knives were soaked, 60°C was less effective than 82°C, reductions in total counts after 60 s being 1.4 and 3.3 log units respectively. Spraying for 60 s with 60°C water gave disinfection equivalent to that achieved by soaking for 60 s at 82°C, giving a reduction in total numbers of bacteria of 3 log units. He obtained similar results when he coated the knives with meat contaminated with *Listeria innocua*.

Food Science Australia studies

Laboratory study

Midgley and Eustace (2003) reported a series of laboratory trials carried out to investigate the effectiveness of hot water immersion for inactivating test bacteria on knives deliberately coated with a layer of fat or mince suspension spiked with *E. coli.*

For each of the trial runs, knife blades were coated with either fat or mince mixture containing *E. coli.* Each knife was held under a flow of hand-wash water at 33°C for 1 s each side to remove any material that was only loosely adhering to it. One side was swabbed after which the knife was immersed in 72, 75 or 82°C water for 10, 15 or 30 s. After the specified immersion treatment, it was removed and Side B of the knife surface was swabbed.

Table 2. Reductions of *E. coli* numbers on knives after immersion in water for various times and temperatures, using fat and mince to contaminate knives.

Treatment	Temp (°C)	Time (s)	Reduction in *E. coli* count (log_{10} units)
Meat matrix			
Hot water	72	15	3.5
Hot water	75	10	3.3
Hot water	82	10	3.2
Hot water	72	30	4.5*
Hot water	75	30	4.7*
Hot water	82	30	4.2*
Fat matrix			
Hot water	72	15	3.6

Hot water	75	10	4.2
Hot water	82	10	3.8

The reductions in numbers of *E. coli* on test knives coated with fat or meat residue are shown in Table 2. The data presented are means of at least two replicates for each time-temperature treatment. Immersion of the knives for 30 s consistently resulted in reductions of greater than 4.2 $\log_{10}$ *E. coli*, and reductions were reliably at least 3.5 log units for immersion times of 15 s or longer. Reductions after immersion for just 10 s were sometimes slightly less.

In those plants where two-knife systems are used, the residence time of the knife in the steriliser depend on the chain speed and the particular operator procedures. Where the knives are swapped only when operators pass from one carcase to the next, residence time varies from about 17 seconds for an abattoir killing over 200 cattle per hour, to over 60 seconds for smaller abattoirs. For most plants the residence time is greater than 30 seconds.

In-plant study

Knife steriliser locations were selected where systematic alternate use of two knives gave long contact times with hot water, allowing investigation of extended periods of disinfection. The stations were: hind leg opening, heads dressing, evisceration, and fat trimming. During the trial the temperature of each test bath was either adjusted to 72-73°C by restricting the in-flow of hot water and by addition of cold water or operated at the normal temperature of 82°C.

One side of each knife blade was swabbed after the knife had been washed in the hand-wash water but before its immersion in the hot water; the other side of each blade was sampled after immersion at 72°C for 15 s, or at 82°C for around 1 s.

Reductions in TVCs occurred after both the pre-wash and hot water (72°or 82°C) steps (Table 3). There were also measurable reductions in *E. coli* at the legging and heads boning locations, and to a level that was below the limit of detection at the evisceration and fat trim locations. Pre-washing under the hand-wash water removed most of the bacteria and almost all particulate residues.

Table 3: Numbers of bacteria (TVC) on pre-washed knives directly attributable to immersion in hot water

TVC [1] on knives after task [2]	2.11	2.46
Reduction after:		
Pre-wash	0.55	0.62
Hot water	*72 °C/15 s*	*82 °C/1 s*
	0.74	0.55
TVC on knives before task (i.e. after cleaning)	0.82	1.29
E. coli [4] on knives after task (%)	50	50

E. coli [4] on knives before task (%) (i.e. after pre-wash and hot water)	8.3	4.2

[1] Mean log10/cm2
[2] Tasks included: hind leg opening, heads boning, evisceration, backs trimming

Alternative procedures for physical removal of bacteria

Published studies

Lowry (1991) compared the residual microbial loading on ovine roller scalpers and viscera collection trays in a New Zealand export plant after washing them with 82°C, 43°C or 22°C water. He found no difference between the 82°C and other treatments in either coliform numbers or total counts and concluded that the washed surfaces did not reach a temperature high enough for long enough to effect pasteurisation. The appearance of an opaque film on some surfaces washed with water at 22°C indicated some fat build-up. Water at 43°C, however, appeared effective in this regard.

Bell and Hathaway (1996) measured the effect of knife cleaning at the work station where opening hind leg cuts were made during sheep processing in a New Zealand abattoir. Before cleaning, knives had a mean log TVC/cm^2 of 5.04, reflecting the heavy soiling which can occur at this site on the fleece. Rinsing the knife in hand-wash water at 44°C reduced the total count on the blade by 1.75 log units or 98.2%.

Thiaudiere (1994) found that for cleaning soiled knives, spraying water at 60°C for 60 s was superior to soaking for the same time and temperature and equivalent to soaking them for 60 s at 82°C giving leaving a residual mean log number of 2.0 per cm^2, a mean reduction of 3.3 log units. After spraying with water at 60°C for 15 s, 30 s and 60 s respectively, reductions in numbers of bacteria were 2.1, 2.9, and 3.3. From investigations with stainless steel and other surfaces coated with blood, fat, and protein, Weise and Levetzow (1976) found washing for 30 – 120 s was better when the water was at 60°C than at 20°, 50° or 82°C. In order to allow for temperature fluctuation in supply lines, they proposed that 65°C was optimum, allowing complete removal of fat and protein material by treatment for 30 s.

FSA study

In the in-plant study reported by Midgley and Eustace (2003) the average total bacterial count on knives after washing under hand-wash water was $\log_{10}$ 1.75/cm^2 (Table 4). Based on the standard deviation value of 0.99, 95 knives in every 100 would have fewer than 5,500 bacteria/cm^2 after washing. For knives used after hide removal, 95 in every 100 would have fewer than 1,100 total bacteria/cm^2.

Table 4. Total bacteria on naturally contaminated knives, before and after rinsing knives under hand-wash water – beef floor.

	Average total bacterial count on knives (log CFU/cm^2)	
	Before hand-wash water (n= 94)	After hand-wash water (n= 142)
Before hide removal[#]	3.0 (±0.7*)	2.3 (±0.74)
After hide removal	1.8 (±0.83)	1.2 (±0.92)

All samples	2.4 (±0.97)	1.75 (±0.99)

'Before hide removal' samples include knives used at the 1st leg, hock cutting, heads, tongues and cheek removal locations. 'After hide removal' samples include evisceration, tendons, and fat trimming locations.

* Standard deviation

MLA study 2004

On the beef floor the mean log TVC on 230 knives (10 from each of 23 task stations) was 2.20 after the current regime, 1.78 after the alternative regime (Table 5). *E. coli* was detected on 20 and 21 knives (of the 230 in each set) respectively. On the mutton floor the mean log TVC on 130 knives (10 from each of 13 task stations) was 1.87 after the current regime and 1.69 after the alternative one. *E. coli* was detected on 24 and 29 knives (of the 130 in each set) respectively. For both floors, the means for TVCs were slightly lower when the alternative system was used, although the differences were not statistically significant. The differences between the systems in prevalence of *E. coli* were not statistically significant.

Table 5. TVCs and prevalence of *E. coli* on knives cleaned by current or alternative procedure – MLA study at M C Herd

	Current system (1 knife, 82°C)	Alternative system 2-knife, 60°C)
Beef floor		
TVC [1] on knives before task (i.e. after cleaning)	2.20	1.78
E. coli [2] on knives before task (%)	8.7	9.1
Mutton floor		
TVC [3] on knives before task (i.e. after cleaning)	1.87	1.69
E. coli [4] on knives before task (%)	18.5	22.3

[1] Mean log10/cm^2, 23 tasks
[2] Positive/total knives tested out of 10 knives at each of 23 task stations
[3] 13 tasks
[4] Positive/total knives tested out of 10 knives at each of 13 task stations

CONCLUSIONS

A review of the scientific and technical literature and of current regulatory requirements on the use of 82°C water for the disinfection of knives and other abattoir implements indicates that it is not always effective in maintaining the knives and equipment in a clean and sanitary condition during processing nor is its use necessary.

Hot water at 82°C will denature proteins and fix them onto surfaces and by doing so will impair its bactericidal effect. Therefore it is important that the hot water be preceded by a wash treatment. The available evidence suggests that washing knives makes a greater contribution to maintaining the knives and equipment in a clean and sanitary condition during processing than does their brief immersion in 82°C water.

Demonstrating in-plant that an alternative procedure does not result in bacterial numbers on knives that are higher than found after treatment at 82°C, as M. C. Herd has done, is a suitable way of demonstrating equivalence.

Based on the results from the investigation undertaken at M C Herd, it may be concluded that the proposed regime will maintain knives in sanitary condition and will not compromise the safety of the carcase and meat parts on which they are used, thereby meeting the requirement of AS 4696-2002 and the Export Control Orders. The proposed regime is also consistent with the requirements of the Food Standards Code.

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APPENDIX

Application to the Meat Standards Committee

Validation of an alternative procedure for knife cleaning on the slaughter floor

M. C. Herd Pty Ltd
Corio

February 2005

Item 5.1.3 - Standards - alternative compliance for equipment sanitising; application by MC Herd Meat Standards Committee, Sydney, 2 March 2005

Contents

Preface

In 2003 M. C. Herd participated in a project carried out by Food Science Australia (FSA): *Investigation of alternatives to 82 °c water for knife and equipment sterilisation.* The findings of the study (Report PRMS. 037 to Meat and Livestock Australia) indicated that knife cleaning could be carried out just as effectively at temperatures cooler than the 82°C which has been the industry standard for several decades.

In 2004 we decided to progress the FSA study with the intention of validating an alternative procedure for knife cleaning. MLA assisted this process in two ways: in helping draft a scientific testing protocol satisfactory to PrimeSafe and in making available technical assistance under the MLA Undergraduate Program. Chris Laurent, an engineering student at University of New South Wales, worked at my plant for 10 weeks in close association with my QA department and with MLA. Over that time he generated a large body of data on the effect of our current knife cleaning regime (momentary dipping in 82°C water) and an alternative procedure (a 2-knife system in 60°C water).

The validation study is now ready for submission to Meat Standards Committee and AQIS for evaluation. The present report forms the basis of our submission.

Frank Herd
February 2005

Item 5.1.3 - Standards - alternative compliance for equipment sanitising; application by MC Herd
Meat Standards Committee, Sydney, 2 March 2005

Executive summary

1. A validation study has been carried out at M.C. Herd Pty Ltd in connection with an alternative procedure for cleaning of knives between carcases on the slaughter floor.

2. The study follows a pilot study undertaken by Food Science Australia in 2003 in a Meat and Livestock Australia project: Investigation of alternatives to 82°C water for knife and equipment sterilisation. Report PRMS. 037

3. Over the period December 2004-February 2005, M. C. Herd has employed an undergraduate who has worked with Herd QA staff and with Meat and Livestock Australia (MLA) to provide data according to a staged protocol approved by PrimeSafe in November 2004.

4. A baseline was established for the microbiological quality of knives after cleaning by the industry standard of momentary dipping in 82°C water in "sterilizers".

5. An equivalent procedure was trialled using a 2-knife system in 60°C water.

6. On the beef floor, prevalence of *E.* coli was similar for both cleaning systems (10% for 82°C versus 9.5% for 60°C) and the mean log TVC was lower using 2 knives and 60°C water (1.78 versus 2.20/cmZ).

<u>*E.* coli and TVCs of knives cleaned in 82°C or 60°C water on the beef floor</u>

System	*E. colt'*	Log TVC/cm2	
		Mean	St dev
82°C	23/230 (10%)	2.20	0.53
60°C/2-knife system	21/230 (9%)	1.78	0.63

Positive/Total knives tested

On the mutton floor mean log TVCs were almost identical for the two knife cleaning systems. However, prevalence of *E. coli* was higher using the 2-knife system at 60°C (22% versus 19%a).

<u>*E. coli* and TVCs of knives cleaned in 82°C or 60°C water on the mutton floor</u>

System	*E. coli"*	Log TVC/cm2	
		Mean	St dev
82°C	25/130 (19%)	1.87	0.75
60°C/2-knife system	29/130 (22%)	1.68	0.43

Positive/Total knives tested

7 The effectiveness of the alternative procedure was evaluated by Food Science Australia who state "The trial that is described in the application ' Use of hot water at less than 82°C for sanitation of knives and equipment' is a logical and desirable extension of the earlier experimentation that I supervised. From your Stage 1 results *and the* progress summary *of* the Stage 2 results to date, the microbiological status *of* the knives after they were *washed and* immersed for *a* time *in 60°C* water appears just as good as *when the* knives were immersed in 82'C water. Indeed, for the knives on the beef line, the results from the two knife alternative *and immersion* in the *60°C* may even be better *than brief immersion of* single knives at 82°C. The investigation to date indicates that the routine pre-wash *of knives and other* equipment followed by a sanitising step in hot water (as outlined in stage 2) result *in* equipment on *which the* numbers of micro-organisms are reduced to a level that will satisfy the *requirements of AS 4696 and the Food Standards Code.*
In my opinion your proposed stage 3 will not compromise your ongoing carcase hygiene status. It will provide the evidence needed to confirm that your carcase hygiene is not compromised and meets the criteria set out in your application."

8 In making this application we note that under "Equivalence" on page (vi) of the Standard that "The submission must include a HACCP Plan which ensures that equivalence is maintained." In response to this requirement, MC Herd make the observation that it is standard practice for all slaughter establishments in Australia to not include knife cleaning within the HACCP plan but as a Good Manufacturing Practice (GMP).

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9 The proposed system will improve safety of the workforce. Scalds from 82°C water is a major cause of injury in abattoirs and cleaning knives at 60°C will significantly reduce the scale of injury due to accidental spillage.

10 The proposed system will also reduce significantly condensation on both slaughter floors, particularly from viscera tables.

11 If this submission is successful, M. C. Herd plans a rigorous implementation phase prior to switching to using a 60°C water/2-knife system. This phase will see conversion of steriliser units to accommodate two knives, staff training in the new system, together with major engineering changes to viscera tables and large pieces of equipment such as hock cutters and brisket scissors to ensure an equivalent process. This phase will be done in close cooperation with PrimeSafe.

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Introduction

1.1 Industry and company profile

The red meat industry in Australia is one of the largest industries in the country. It produces beef and veal per year of which 62.8% is exported with the remainder consumed locally. This makes Australia the largest beef exporter and the third largest beef-producing nation

Australia also produces large amounts of lamb and mutton producing 341,449t and 219,714t, respectively, of which a large proportion of lamb (36%) and mutton (71.5%) being exported. Australia is the second biggest exporter of lamb and mutton behind New Zealand.

M C Herd is a domestic and export registered abattoir with integrated boning room, and freezer store. The company processes cattle, calves, sheep and lamb. The beef floor consists of one on-rail process chain (one continuous flowing) system with a Johnson upward hide puller capable of processing up to 600 bodies per day. The smallstock floor comprises an inverted system capable of handling up to 5000 bodies per day. Both floors employ Halal slaughtermen. There is an on-site rendering plant that produces meat meal and inedible tallow. Hides and runners receive further processing off-site

In 2003, M.C. Herd was the nineteenth biggest red meat processor with a carcase dressed weight of 37,OOOt which accounted for 1.5% of the national total. The plant is a Tier 1 registered establishment that complies with the Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption (AS 4696: 2002). The company employs a team of Quality Assurance Officers, each of whom is licensed with the Victorian regulator, PrimeSafe. The company is certified to ISO 9002 and receives 3ro party audits together with 2"° party oversight from PrimeSafe and AQIS.

1.2 Present project - cleaning of knives

In 2003 the company participated in a PRMS.037: 'Investigation of alternatives to 82°C water for knife and equipment sterilisation', a project undertaken by Food Science Australia (Midgley and Eustace, 2003). Based on the findings of the FSA study, in 2004 M. C. Herd resolved to set in motion a validation project to install an alternative procedure for knife cleaning.

The regulatory basis for knife cleaning is included in AS 4696-2002 (Clause 20.5) requires that facilities for cleaning and sanitising implements ...are *provided with* an adequate supply *of* hot potable water at no less *than 82*°C or an equivalent method of sanitising."

M.C. Herd wished to clean knives at a temperature cooler than 82°C and designed a protocol for a stepwise investigation approved by PrimeSafe (see Appendix 1 for full design protocol). Midgley and Eustace (2003) listed potential benefits from using temperatures cooler than 82°C for cleaning knives including:

- *Reduced risk of* operator injury through scalding
- *Reduced hot* water consumption during knife and equipment cleaning
- Reduce impact *of* hot water on effluent ponds
- *Reduced fogging* and condensation
- Potential reduction in maintenance requirements

1.3 Historical background to knife cleaning

Prior to the introduction of metrication in Australia, water in knife cleaning baths was required to be no colder than 180°F and, during metrication a simple conversion was made to 82°C. However, scientific unpinning for the requirement to use 180°F/82°C for cleaning knives and equipment are unclear. There are sound scientific bases for temperatures such as 65°C for cooking (reduction of Gram-negative and some Grampositive pathogens), 72°C/15 seconds (pasteurisation) and 121 °C for sufficient time to achieve commercial sterility. However, no corresponding treatment time is provided in meat hygiene texts to account for the 82°C/180°F requirement.

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Midgley and Eustace (2003) undertook a rigorous search of the literature in an attempt to unearth scientific reasoning to explain the 82°C/180°F requirement and their account is reproduced verbatim here as it represents the most authoritative account of the history of equipment cleaning in the meat industry.

Publications earlier than 1960 refer to a number of equipment cleaning procedures. For example, two publications suggest that water should be heated to 140°F for one minute or to 130°F for 5 minutes to sterilise low temperature types of organisms by heat (Collins, 1954; Empey and Scott, 1939). Collins states that knives and saws should be replaced and subjected to immersion in alkali at 160-180°F after twelve carcases have been processed. Another comment is that the circular saw used for carcass splitting must be periodically wiped clean of all visible blood and sawdust.

Past and present staff at the United States Department of Agriculture have provided a number of opinions on the origins of the 82°C water requirement (Brewer, R. personal communication March 2002). In the 1950s Dr Sloan, working for the USDA Agricultural Research Service (ARS) in Beltsville, Maryland, is believed to have investigated methods of sterilising carcass-splitting saws. Sloan found that dipping the carcass splitting saws in 180°F water effectively killed sufficient numbers of organisms to satisfy regulatory requirements. Eventually 180°F water became the standard for all slaughter floor operations.

Shortly after, when automated poultry eviscerating equipment was being developed it was determined that too much 180°F hot water was needed to economically achieve proper sterilisation of the poultry equipment. Sloan then developed a spray technique for disinfection during operations using 50 ppm chlorine. This concentration of chlorine damaged the equipment that was then installed in poultry processing plants. Sloan subsequently found that 20 ppm chlorine was effective on poultry equipment without damaging it and chlorine at this concentration is still being used. Unfortunately, there is no evidence of publication of Sloan's studies and during changes of administrations at USDA, reports of most of the old investigations of anything pertaining to sanitation were discarded.

A possible alternative explanation is that the 180°F requirement was based on the heat resistance of a particular zoonotic pathogen (Brewer, R. personal communication March 2002). Historically, tuberculosis was a widespread concern in the 1950s. Water at 82°C may have been chosen as the knife sterilisation procedure that would kill the tubercule microorganism Mycobacterium tuberculosis, the primary target organism in milk and other foods at that time.

1.4 Current thoughts on the scientific underpinning for knife cleaning

Midgley and Eustace (2003) consider that current industry practice of momentary dipping in 82°C water is not sufficient to ensure a significant bactericidal effect. Importantly, thermal inertia of the equipment will prevent surfaces attaining the water temperature until several seconds have elapsed (Lowry, 1991) and Peel and Simmons (1978) showed that momentary immersion of knives at 82°C was ineffective in decontaminating knives of salmonellas. When fats or proteins are present, immersion at 82°C for as long as 10 seconds will not give satisfactory reduction in bacterial contamination (Snidjers et a/., 1985). Also, hot water at 82°C was found to affix proteins onto the surface of the equipment (Weise and Levetzow, 1976; Schiitt-Abraham et al., 1988) leading to possible entrapment of bacteria and cleaning difficulties.

It was against this background that M.C. Herd embarked upon an evaluation procedure for an alternative knife cleaning system, aiming to determine whether cleaning in 60°C water could lead to an outcome equivalent to momentary immersion in 82°C water.

The company proposed a three step trial: Step 1: Undertake a line survey to establish baseline contamination loadings on knives and equipment after 82°C treatment Step 2: Establish whether water cooler than 82*C can produce an equivalent outcome by extending the immersion time Step 3: Monitor hygienic quality of carcases and selected offals processed using knives and equipment via the current and alternative systems

Appendix 1 contains full details of the company proposal to PrimeSafe to undertake the present study.

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2. Materials and Methods

2.1 Study design

A series of experiments was carried out at MC Herd, to compare contamination levels on knives cleaned by dipping in 82°C water with those on knives employed in a 2-knife system in 60°C water.

2.2. Sponge sampling of knives

Knife blades were sampled immediately after the operator had cleaned the knife either in 82°C or 60°C water using a sterile polyurethane sponge (Nasco Whirlpak) hydrated in 2 % (w/v) buffered peptone water. The sponge was doubled over the back of the knife and the blade wiped from handle to tip. A protective glove was worn by the operator beneath the rubber glove to protect against cut wounds.

2.3 Transportation of samples to the laboratory

After sampling, sponges in sterile bags were taken to the onsite laboratory for immediate testing. In the laboratory, samples were held in a refrigerator until analysed.

2.4 Knife cleaning methods

Two knife-cleaning regimes were used. Firstly, the knife was cleaned by momentary dipping in a "steriliser" maintained no cooler than 82°C. For the alternative cleaning regime a portable steriliser containing a thermostatically controlled heating element (Ratek TH1 thermoregulator) was used to maintain a temperature no cooler than 60°C. A data logger was placed in the steriliser to record water temperature during use. A two-knife system of knife cleaning at 60°C in which one knife remained in the "steriliser" for the period while the other knife was used on the carcase. The operator exchanged knives between carcases.

2.5 Determination of Total Viable Count (TVC) and E.coli

The sponge was squeezed firmly through the plastic bag and, from the moisture expressed, serial dilutions were prepared in 0.1°/a buffered peptone water blanks (9 mL) using 1mL aliquots. Aliquots (1 mL) from each dilution were spread on either Aerobic Plate Count Petrifilm (3M) or E coli Petrifilm (3M) and incubated at 20-25°C/3 days and 37°C for 2 days, respectively. Colonies were identified and counted as per the manufacturers instructions.

2.6 Statistical analysis

When *E.* coli was absent from Petrifilms the result was entered as "not detected". TVCs were converted to logo cfu/cmz and the mean of the logo cfu/cm2 was calculated. The standard deviation was determined using Microsoft Excel software. The limit of detection for both TVC and *E.* coli was 0.36 cfu/cm2. In general knives at each station were tested in quintuplicate with each result the mean of 5 tests. In the baseline study (82°C) of the forequarter station on the mutton chain 20 replicates were tested.

2.7 "Steriliser" temperatures

The existing sterilisers are overflow sterilisers and are filled from a hot water pipe at 88'C descending from above. The temperature is checked regularly during processing by the beef and mutton floor foremen and recorded. When the portable steriliser was used its temperature was measured using a Gemini tinytag plus data logger

3 Results

Knives were tested at a range of stations located along the beef and mutton slaughter floors (Fig 1) and E. coli and Total Viable Counts (TVCs) obtained.

Fig 1: Location of stations at which knives were tested

Halal cut

Weasand ti e

Sticking

Rinsing

Scalping

Inleg

2°'d 1 eg

Air knife 1

Air knife 2

Air knife 3

Air knife 4

Tongue drop

Heads inspection

Head boning

Bung drop

Evisceration

Viscera in specti on

Front's inspection

Separate runners

Neck trim

Wizzer knives

Backs inspection

Backs trim

Beeffloor

Sticking

Briskets

Fore quarters Heads

off flax eyes Tail trim

Neck trim Bung

drop Pluck removal

Evisceration Viscera

inspection Separate

runners

Pluck table

Mutton flc

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3.1 Microbiological status of cleaned knives on the beef floor

In Table 1 are presented TVC and *E.* coli prevalence at stations along the beef chain. The mean log TVC/cm2 was 2.20. In general, higher TVCs occurred earlier in the process, when cuts were made through the hide. This is especially so for the four air knives used, which are difficult to clean, and on knives used at the head stations. E. coli was found to be present on cleaned knives on 14/115 (12%) occasions and the mean log of positive knives was -0.03/cm2 (0.9/cm2) on Run 1 and on 9/115 (8%) occasions and the mean log of positive knives was 0.004/cm2 (1/cm) on Run 2 suggesting that detection of *E.* coli on cleaned knives is a random occurrence dependent on the level of contamination loaded onto the knife blade by cuts which preceded the cleaning process.

Table 1: *E.* coli and TVCs of knives cleaned in 82°C water on the beef floor

Station	*E.* colt"		Log TVC/cm2	
	Run 1	Run 2	Run I mean	St dev
Halal cut	2	1	1.49	0.22
Weasand tie	1	1	2.77	0.32
Sticking	0	0	2.34	0.73
Rinsing	0	0	2.34	0.73
Scalping	0	0	1.56	0.59
1 st leg	1	0	1.64	1.09
2nd leg	0	0	1.72	0.13
Air knife 1	1	0	2.33	1.22
Air knife 2	2	1	3.44	0.09
Air knife 3	1	0	2.31	0.66
Air knife 4	1	0	2.21	0.78
Tongue drop	0	1	3.85	0.00
Heads Inspection	0	0	3.85	0.00
Head Boning	0	1	3.48	0.16
Bung drop	0	0	2.35	1.64
Evisceration	3	2	1.35	0.29
Viscera inspection	1	1	1.48	1.06
Fronts inspection	0	0	1.77	0.55
Separate runners	0	1	1.54	0.58
Neck trim	0	0	1.70	0.37
Whizzard knives	0	0	1.90	0.55
Backs inspection	1	0	1.95	0.15
Backs trim	0	0	1.14	0.63
Totals and means	14/115	9/115	2.20	0.55

*Number of knives testing positive for *E.* coli out of 5 knives sampled at each station

An alternative knife cleaning system was trialled where a 2-knife system was operated using water at 60°C. A portable steriliser unit was used for this purpose and, after the operator's knife had been sponged, it was dipped in 82°C, water in order that the knife received the prescribed cleaning prior to contacting the carcase.

As seen from Table 2, the mean log TVC/cm2 for knives at all stations were 1.74 and 1.82 for runs 1 and 2, respectively. Higher counts were again seen on air knives and with head procedures, as well as bunging and separation of runners. *E.* coli was detected on 10/115 (9%) and 11/115 (10%) occasions and the mean log of positive knives was 0.21/cm2 (1.6/cm2)

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Table 2: *E* coli and TVCs of knives cleaned usin a 2-knife system in 60°C water on the beef floor

Station	E.coli*		Log TVC/cmz			
	Run 1	Run 2	Run I mean	St dev	Run 2 mean	St dev
Halal cut	0	0	1.93	0.70	2.05	0.58
Sticking	0	0	1.92	0.68	3.13	0.66
Weasand tie	1	1	1.94	1.33	2.09	0.46
Rinsing	0	0	2.14	0.34	1.93	0.51
Scalping	0	1	0.93	0.79	2.72	0.44
1 st leg	0	1	0.83	0.17	1.39	0.85
2nd leg	0	0	1.91	1.20	1.11	0.42
Air knife 1	1	1	1.61	0.35	1.72	0.47
Air knife 2	2	0	2.64	0.43	2.38	0.33
Air knife 3	2	4	1.52	0.37	2.44	0.25
Air knife 4	0	0	2.25	0.39	2.25	0.18
Tongue drop	0	1	1.99	0.49	1.47	0.32
Heads Inspection	0	0	1.11	1.17	1.27	0.28
Head Boning	0	0	1.35	0.53	1.24	0.37
Bung drop	0	0	2.32	0.34	2.21	0.61
Evisceration	0	0	1.04	0.89	0.84	0.35
Viscera inspection	2	0	2.09	0.45	0.99	0.44
Fronts inspection	0	0	1.52	0.18	1.76	0.68
Separate runners	2	0	2.72	0.32	1.03	0.18
Neck trim	0	0	1.92	1.15	1.82	0.90
Whizzard knives	0	0	1.02	0.29	1.04	0.44
Backs Inspection	0	2	1.49	0.29	2.57	0.28
Backs trim	0	0	1.89	0.88	2.45	0.74
Totals and means	10/115	11/115	1.74	0.60	1.82	0.47

*Number of knives testing positive for *E.* coli out of 5 knives sampled at each station

3.2 Microbiological status of cleaned knives on the mutton floor

In Table 3 are presented TVCs and *E.* coli counts from knives cleaned in 82°C water on the mutton floor. The mean log TVC/cm2 of cleaned knives was 1.87 with higher counts being associated with procedures involving intestines (bung drop, evisceration, runner separation). *E* coli was isolated from cleaned knives on 16/80 (16%) and 13/80 (15%) occasions and the mean log of positive knives was 0.72/cm2 (5.2/cm2) and 0.15/cm2 (1.4/cm2) in Runs 1 and 2, respectively.

In Table 4 are presented TVC and *E.* coli counts for knives in a 2-knife system on the mutton floor cleaned in water at 60°C. Mean log TVC/Cm2 for all knives was 1.70 in Run 1 and 1.67 in Run 2 with higher counts coming at the heads **off and wax** eyes stations. Note that bodies pass these stations (which are at the same point in the chain) at the most rapid speed allowing little time for knife cleaning. E. coli was detected on cleaned knives on 17/65 (26%) and 12/65 (18%) occasions and the mean log of positive knives was

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Table 3: *E.* coli and TVCs of knives cleaned in 82°C water on the mutton floor

Station	*E.* coli*		Log TVC/cm2	
	Run 1	Run 2	Run 1 mean	St dev
Sticking	0	0	0.73	0.74
Briskets	2	0	2.36	1.20
Forequarters	0	1	1.88	1.18
Heads off	1	0	1.92	0.51
Wax eyes	0	0	1.64	1.17
Tail trim	0	3	0.50	0.33
Neck trim	0	1	2.25	0.72
Bung drop	3	3	2.39	0.54
Pluck removal	0	3	1.81	1.36
Evisceration	4	0	3.04	0.17
Viscera inspection	1	0	2.13	0.23
Separate runners	1	0	1.61	0.51
Pluck table	1	1	2.02	1.04
Totals and means	13/80	12/80	1.87	0.75

*Number of knives testing positive for *E.* coli out of 5 knives sampled at each station except for the forequarter station where 20 knives were sampled on each run

Table 4: *E.* coli and TVCs of knives using a 2-knife system/60°C water on the mutton floor

Station	E. coli*		TVC			
	Run 1	Run 2	Run I mean	St dev	Run 2 mean	St dev
Sticking	0	0	1.97	0.17	0.95	0.21
Briskets	3	1	2.03	0.16	2.04	0.33
Forequarters	0	0	1.22	0.44	1.27	0.25
Heads off	0	0	2.70	0.38	1.58	0.45
Wax eyes	1	0	2.43	0.65	0.94	0.31
Tail trim	3	3	1.85	0.45	2.35	0.63
Neck trim	0	0	2.29	0.24	2.05	0.53
Bung drop	5	4	1.62	0.51	2.55	0.62
Pluck removal	0	2	0.77	0.30	1.26	0.71
Evisceration	1	1	1.12	0.31	1.43	0.77
Viscera inspection	2	1	1.59	0.44	2.14	0.61
Separate runners	2	0	1.60	0.57	1.65	0.39
Pluck table	0	0	0.91	0.36	1.49	0.49
Totals and means	17/65	.12/65	1.70	0.38	1.67	0.48

'Number of knives testing positive for *E*, coli out of 5 knives sampled at each station

3.3 Microbiological status of large pieces of equipment and viscera table

Table 5 contains TVC and *E.* coli counts for large equipment and viscera tables on the beef floor. Mean log TVC/cm2 was 1.16 (14/cm2) with higher counts occurring on hock cutters; *E.* coli contamination was found on 3/60 knives and the mean log of positive knives was -0.01/cm2 (1/cm2)

Table 5: *E.* coli and Total Viable Counts of large pieces of equipment and the viscera table cleaned in 82°C water on the beef floor

Station	*E.* coli"	Log TVC/cmz	
		Mean	St dev
1 st leg hock cutters	0/10	2.56	0.73
2nd leg hock cutters	1/10	2.94	0.84
Brisket saw0/10	0.82	0.59	
Carcase split	2/10	1.80	0.64
Viscera table	0/20	0.19	0.28
Totals and means	3/60	1.16	0.56

" Positive/total knives tested

In Table 6 there are values for TVCs and *E.* coli from large pieces of equipment cleaned at 82"C. Mean log TVC/cm2 was 2.17 (147/cm2) with all counts being similar; *E.* coli contamination was found on 10/55 knives and the mean log of positive knives was 0.29/cm (1.9/cm2)

Table 6: *E.* coli and Total Viable Counts of large pieces of equipment and the viscera table cleaned in 82°C water on the mutton floor

Station	*E. coh"*	Log TVC/cm2	
		Mean	std
Punching arms	0/10	2.18	0.31
Hock tip cutter	0/10	1.90	0.18
Brisket Scissors	4/10	2.64	0.97
Viscera table	6/25	2.13	0.49
Totals and means	10/55	2.17	0.69

" Positive/total knives tested

3.4 Baseline microbiological status of carcases and offals processed at MC Herd

In Table 7 is contained a summary of the microbiological status of beef and sheep carcases processed at M. C. Herd during the period 2002-04. For beef carcases, more than 90% of product conformed with the "Excellent" category of the Microbiological Guidelines which accompany AS 4696:2002. For sheep carcases 37% of were in the "Excellent" and 62.5% in the "Good" category. For prevalence of *E. coli* >90% of product was in the "Excellent" and "Good" categories.

Table 7: Conformance of *E. coli* and TVCs with Australian Standard Microbiological Guidelines of beef and sheep carcases processed at M. C. Herd (2002-2004)

Category	Beef carcases (n=275)		Sheep carcases (n=184)	
	TVC	*E. coli*	*TVC*	*E. coli*
Excellent	91.3%	37.0%	37.0%	22.3%
Good	8.4%	62.5%	62.5%	69.0%
Acceptable	0.4%	0.5%	0.5°/a	8.7%
-Marginal	0%	0%	0%	0%

In Table 8 is summarised the microbiological status of beef and sheep carcases processed at M. C. Herd during the period 2002-04. For beef offals, 78% of product conformed with the "Good" category of the Microbiological Guidelines which accompany AS 4696:2002. For sheep offals 14°/a of were in the "Excellent" and 50% in the "Good" category. For prevalence of E. coli >90% of beef offals and 86% of sheep offals were in the "Excellent" and "Good" categories.

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Table 8: Conformance of *E.* coli and TVCs with Australian Standard Microbiological Guidelines of beef and sheep offals processed at M. C. Herd (2002-2004)

Category	Beef offals		Sheep offals (n=50)	
	TVC (n=41)	*E.* coli (n=62)	TVC	*E. coli*
Excellent	0%	90.3%	14%	68%
Good	78%	8.1 %	50%	18%
Acceptable	22%	1.6%	32%	14%
Marginal	0%	0%	4%	0%

4 Occupational health aspects of knife cleaning

The use of 82°C water in open steriliser units represents a significant personal injury hazard to the abattoir workforce with accidental spillage into rubber boots a major component of workplace injury.

In Fig 2 is illustrated the effect of a scald from spillage into the worker's boot. Injuries were sustained to the calf and ankle.

Figure 2: Typical injuries caused by accidental spillage of 82°C water

As well as pain and suffering, costs associated with burns include medical treatment, time out of the workforce and insurance premiums. In Table 9 are presented summary statistics for burns incurred at M. C. Herd over the period 2002-2005. Over the 37 month period considered there were 42 burns resulting from exposure to 82°C water, accounting for 9% of all injuries at the plant. Total monthly costs are $4200 equating with an annual cost around $50,000.

Table 9: The effect of burns caused by 82°C water (2002-2005)

Total bums/injuries	42/465 (9%)
Average cost of treatment	$1408.34
Average cost of time off	$987.24
Total cost per month	$4215.60
Total cost per year	$50587.18

Many severe incidents can also affect the Insurance Premium that the company pays. Any injury that results in a pay out of $500 or more can affect the insurance premium.

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5 Discussion

5.1 Baseline microbiological contamination on knives cleaned in 82°C water

The present study has, for the first time, established a microbiological baseline for knives used along the entire beef and mutton chains after the process termed "sterilising". It is generally accepted by microbiologists that this term is a misnomer with "sanitising" an appropriate descriptor. In the Australian Standard for the Hygienic Production and Transportation of Meat for Human Consumption (AS 4696:2002) "sanitise" is defined as `means to apply heat, chemicals or other processes to a surface so that the *number of* micro-organisms on the surface are *reduced to* a level that: (a) does not compromise the safety *of* meat or meat products *which may* directly or indirectly come into contact with the surface; *and* (b) does not permit the *transmission of* infectious disease." The Standard does not further define a level which does not compromise product safety or infectious disease. However the Microbiological Guidelines that accompany the Standard define a level for cleaned and sanitised contact surfaces as TVC no more than 5/cm2. From the present study, knives cleaned by momentary immersion in water at 82°C do not meet the performance criterion for product working surfaces, which must undergo chemical cleaning and sanitising steps and it is unrealistic to expect equivalence of these processes.

It may be that there is an expectation that the process of momentary dipping in 82°C water will completely remove organisms of faecal origin from the knife. The present study indicates that faecal organisms will not always be removed during "sterilising" and that persistence of such organisms is related to the microbial load on the knife prior to cleaning. Thus knives used for "dirt' operations such as incising areas of the hide/pelt which have faecal contamination, or freeing the bung are more likely to bear *E.* coli and to have TVCs >102/cm2 after the cleaning process at 82°C.

Similar loadings on cleaned knives on New Zealand slaughter floors were determined by Bell (1997) who also established that the knife hand of the operator was more contaminated than the knife, both before and after cleaning (Table 10). The level on cleaning knives (log TVC 2.64/cm2) was higher than the baseline established in the present study for knives used on the beef (log TVC 2.20/cm2) and mutton floors (log TVC 1.87/cm2). The study of Bell (1997) is also of interest firstly in indicating that the cleaning process reduced the total microbial loading by one log scale and secondly, that the knife hand is generally one log scale more contaminated than the knife, both before and after cleaning.

Table 10: TVCs of knives before and after cleaning in 82°C water on a beef slaughter floor

Station	Mean log TVC/cm2	
	Before cleaning	After cleaning
Knife hands (n=20)	4.74	3.73
Knife blades (n=20)	3.61	2.64

As an adjunct to the present study the effect of momentary dipping in 82°C water was investigated on a pork slaughter floor. As indicated in Table 11 counts varied according to process station from log 0.64 to log 3.52/cm2, with a mean from all stations being log 1.98/cmz. *E.* coli was present on 7/30 (23%) of cleaned knives and the mean log of positive knives was 0.25/cm2 (1.8/cm2).

Table 11: E. coli and TVCs of knives cleaned in 82°C water on a pig slaughter floor

Station	*E.* coli*	Log TVC/cm2	
		Mean	St dev
Shaving	5	3.46	0.29
Bung and testes	0	1.65	0.82
Gutting	1	0.64	0.31
Trotter removal	1	1.15	0.64
Backing off	0	3.52	0.18
Final trim	0	1.49	0.99
Totals and means	7/30	1.98	1.26

* Positive/Total knives tested

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Thus TVCs on knives after cleaning from a pig slaughter floor were similar to those on the beef and mutton floors in the present study. Prevalence of *E.* coli in the present study were 10% (beef floor) and 12.5%a (mutton floor) which are rather lower than that of the pig slaughter establishment (23%) though it must be emphasised that the latter survey did not encompass all stations along the slaughter line.

The present survey therefore establishes microbial levels on knives cleaned by momentary dipping in 82°C water as mean log 2.0-2.5/cm2 with *E.* coli prevalence over the whole slaughter line as 10-12%. The study also establishes variation between knives used at "dirty" stations, where the cleaned knife may regularly be contaminated with *E.* coli and the log TVC >3.0/cmz.

In reference to the definition of sanitising in the AS the foregoing indicate that on the 10-12% of knives which bear *E.* coli after cleaning a level of mean log 0.08/cmz (1.2/cm) is unlikely to be indicative of pathogen transfer.

5.2 Microbiological contamination on knives cleaned in 60°C water using a 2knife system

An alternative system of cleaning knives was trailed using a 2-knife system with 60°C water. In this system knives had a longer residence time than momentary dipping to balance the sanitising effect of water temperature (82°C versus 60°C). Residence time varied according to station from more than 30 seconds at legging on the beef floor to < 1 second at the heads off and wax eyes station on the mutton floor. On the beef floor, prevalence of *E.* coli was similar for both cleaning systems (10% for 82°C versus 9.5% for 60°C) and the mean log TVC was lower using 2 knives and 60°C water (1.78 versus 2.20/cm2).

Table 12: *E.* coli and TVCs of knives cleaned in 82°C or 60°C water on the beef floor

System	*E.* cola	Log TVC/cm2	
		Mean	St dev
82°C	23/230 (10%)	2.20	0.53
60°C/2-knife system	21/230 (9%)	1.78	0.63

* Positive/Total knives tested

On the mutton floor mean log TVCs were almost identical for the two knife cleaning systems. However, prevalence of E coli was higher using the 2-knife system at 60"C (22% versus 16%). This difference may reflect differences in lots being processed (and therefore knife loadings pre-cleaning). Another factor is that, for the 82°C baseline, the forequarter chain was sampled on 40 occasions, yielding only 1 knife positive for *E.* coli. For the alternative system, however, only 10 knives were sampled at this station; if prevalences are adjusted to include only 10 knives for each sampling the difference becomes 19% at 82°C and 22% at 60"C/2-knife.

Table 13: *E.* coli and TVCs of knives cleaned in 82°C or 60°C water on the mutton floor

System	*E. cob°*	Log TVC/cmz	
		Mean	St dev
82°C	25/160 (16%)	1.87	0.75
60°C/2-knife system	29/130 (22%)	1.68	0.43

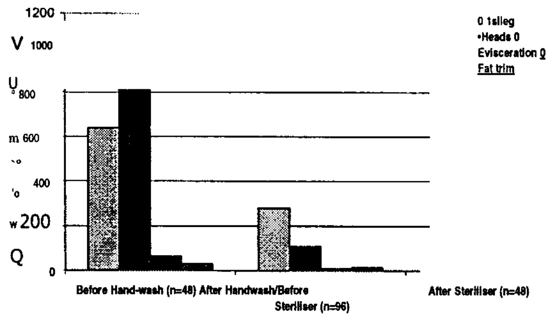
* Positive/Total knives tested

From the foregoing it can be concluded that using 2 knives and cleaning in 60°C water provides a process equivalent to momentary dipping in 82"C water.

5.3 Findings of Midgley and Eustace (2003)

The work of Midgley and Eustace (2003) at M.C. Herd is especially valuable since these workers provided the impetus for the present study. Of particular relevance is a set of experiments in which the researchers monitored natural contamination on knives at three stages in the cleaning process:

- Immediately after use on the carcase
- After rinsing under warm (22-40°C) water



• After momentary dipping in 82°C water

Knives were also monitored at "dirty" stations such as 1s' leg, head removal and "clean" stations such as evisceration and fat trim.

Data for 1'VC and E. coli are summarised in Figs 1 and 2, respectively. Before they were washed, knives from the first leg and heads stations were more highly contaminated with bacteria than other stations. The highest *E.* coli contamination was at the first leg station where the hide is incised at the rear of the animal. The average count of *E.* coli on knives at the station was 41cm2. Washing in hand-wash water effected consistent reductions in TVC and E coli. And immersion in 82°C water caused a further reduction.

The effect of rinsing in hand wash water is especially interesting and, for the 94 knives sampled before and 142 knives sampled after, most bacteria and almost all particulates were removed. *E.* coli was not detected on 108/142 (76%) knives sampled after rinsing in wash-water 129/142 (91%) knives had total viable counts of <1000/cm2. None of the 34 knives on which *E.* coli was detected had counts greater than 13/cm2.

Fig 1: Effect on NC of washing knives in hand wash water followed by momentary dipping in 82°C water

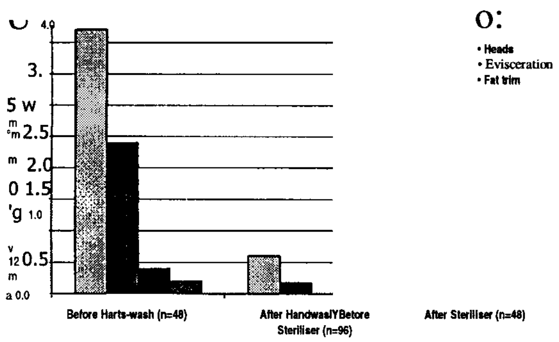


Fig 2: Effect on E. coli of washing knives in hand wash water followed by momentary dipping in 82°C water

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5.4 Microbiological contamination of large pieces of equipment cleaned in 82°C water

On both slaughter floors there are large pieces of equipment (e.g. hock cutter, brisket scissors, carcase splitter) which are cleaned by insertion into a jacket with a spray of 82°C water. Each slaughter floor also has a viscera table where viscera are inspected and some pre-processing of the gut is carried out. A baseline survey along each slaughter floor (Tables 5 and 6) established mean log TVC and E. coli prevalence similar to those for knives. In the present study it was not possible to measure contamination at 60°C. This process involves an alteration to the water temperature entering the equipment cleaning lines. As well, significant engineering work is planned to enhance cleaning of viscera tables by installing additional sprays. When these changes have been completed equipment will be tested using the methodology described in this report.

5.5 Baseline survey of microbiological status of product

Using company monitoring data for the period 2002-2004 a baseline has been established for carcases and offals (Tables 7 and 8, respectively). If an alternative system of knife cleaning is implemented at the establishment these baseline data will serve as the ultimate comparison with the previous system.

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Appendix 1: APPLICATION TO UNDERTAKE A STUDY TO VALIDATE AN EQUIVALENT PROCEDURE

USE OF HOT WATER AT LESS THAN 82°C FOR SANITATION OF KNIVES AND EQUIPMENT

1. Applicant's Details

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2. Reason for and purpose of study

Cleaning and disinfecting knives and equipment in 82°C water, while assessed as effective, has a number of negative aspects. Most importantly, occupational health and safety is compromised by having extremely hot water in open containers, sometimes at elevated locations on the slaughter floor. As well, there are considerable costs in maintaining large volumes of water at such temperatures. Finally, even a small drop in temperature may cause slaughtering to be curtailed which, of itself, introduces food safety issues.

The present project is intended to determine whether temperatures cooler than 82°C can be used for knife and equipment sanitation without compromising food safety and meat quality while, at the same time, protecting health and safety of operators.

A three step trial is proposed:

- A line survey to establish contamination loadings on knives and equipment before and after 82°C treatment.
- Establishing whether water cooler than 82°C is effective in reducing contamination of knives and equipment to an equivalent hygienic state to that achieved by 82°C water.
- Monitoring of hygienic quality of carcases and selected offals processed using knives and equipment that have been demonstrated to have received an equivalent treatment to 82°C water are processed.

3. Background

3.1 Regulatory Standards The Australian Standard for the hygienic production and transportation of meat and meat products for human consumption (AS 4696-2002) requires that:

> "The facilities *for cleaning and sanitising implements ... (c) are provided with an adequate supply of hot potable water at no less than 82°C or an equivalent method of sanitising" (clause 20.5)*

There does not appear to be an authoritative explanation as to why 82°C/180°F has become so entrenched in global meat hygiene regulation. Enquiries with Dr Robert Brewer, a senior member of the USDA FSIS Office of Policy, Program Development and Evaluation, could not find supporting USDA documentation. However he obtained comments from several long-term, or former USDA staff members that it probably dates back to an investigation done by the USDA Agricultural Research Service (ARS) in the 1950s to disinfect splitting saws that might be contaminated with the tubercle organism *Mycobacterium tuberculosis* and other pathogens. It seems that an observation that brief immersion of the saws in 180°F water was an effective disinfection procedure gradually became a mandatory minimum temperature requirement in abattoirs in the US and elsewhere.

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It has been written into some regulations as a sterilisation step although it clearly is not. In laboratories, for instance, steam under pressure is needed for effective sterilisation. Microbiological testing laboratories normally use 121 °C for 15 minutes.

Australia New Zealand Food Standards Code
The Food Standards Code Standard 3.2.2 'Food Safety Practices and General Requirements' contains requirements for the cleaning and sanitising of specific equipment. Attempts to harmonise with the Food Standards Code will assist in the development of a primary production standard for meat in Chapter 4 of the Food Standards Code when that standard is developed.

The requirements of Standard 3.2.2, clause 20 are:

(1) A food business must ensure the following equipment is in a clean and sanitary condition in the circumstances set out below -

(a) eating and drinking utensils - immediately before each use; and
(b) the food contact surfaces of equipment - whenever food that will come into contact with the surface is likely to be contaminated.

(2) In subclause (1), a 'clean and sanitary condition' means, in relation to a surface or utensil, the condition of a surface or utensil where it -

(a) is clean; and
(b) has had applied to it heat or chemicals, heat and chemicals, or other processes, so that the number of micro-organisms on the surface or utensil has been reduced to a level that:

(i) does not compromise the safety of the food with which it may come into contact; and
(ii) does not permit the transmission of infectious disease.

Applied to knife and equipment sanitation in meat processing, this clause would allow several options for treating knives and equipment as long as the safety of meat is not compromised and does not allow the transfer of pathogens to the meat. The proposal to allow treatments other than 82°C for knife and equipment sanitation is consistent with the requirements of the Food Standards Code.

The Guidelines to the Food Safety Standards (issued by ANZFA as 'Safe Food Australia', 2"d ed. 2001) discuss manual processes for sanitising utensils and equipment with a focus on food service (Appendix 4). These Guidelines firstly use a temperature of 77°C as a basis, and also discuss the difficulties posed by this temperature both practically and from an occupational health and safety point-of-view. Alternative temperatures and processes involving chemical and physical processes are discussed.

3.2 Recent Considerations

European Commission In June 2001, The European Commission's Scientific Committee on Veterinary Measures relating to Public Health (SCVPH) adopted an opinion paper entitled 'The cleaning and disinfection of knives in the meat and poultry industry'. Inter alia, SCVPH concluded that using water at 82°C or higher is not fully effective in the absence of cleaning and that use of water at lower temperatures with lactic acid or other agents can be used as a satisfactory alternative to the currently approved procedure.

A proposal, prepared for the Commission in 2000 for a regulation of the European Parliament and of the Council laying down specific hygiene rules for food of animal origin, states that slaughterhouses and cutting plants must have facilities for disinfecting tools with hot water supplied at not less than 82°C, or an alternative system having an equivalent effect.

Codex Alimentarius Commission The Codex Committee on Meat *Hygiene continues to* elaborate a Code *of Hygienic Practice* for Meat (currently at step 6 *of* the Codex Alimentarius process). The Draft Code stipulates that:

163. Particular cleaning programmes are required for equipment used in the slaughter and dressing of carcasses e. ., knives, saws, machine cutters, evisceration machines and flushin nozzles. Such equipment should be:
• clean and sanitised before each new period of work;

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• cleaned, and sanitised, by immersion in hot water or alternative methods, with appropriate frequency during and/or between periods of work;
• immediately cleaned and sanitised when coming into contact with abnormal or diseased tissue that may harbour food-borne pathogens; and
• stored in designated areas in such a manner that it will not become contaminated.

Guidelines are provided in 'single-line boxes' to indicate that they are recommendations based on current knowledge and practice. They should be regarded as being flexible in nature and subject to alternative provisions so long as required outcomes in terms of the safety and suitability of meat are met.

US Department of Agriculture *In its Final* Rule *on Sanitation Requirements for Meat and Poultry Establishments, date of effect 25 January 2000, the Food Safety and Inspection Service rescinded, in Section 416.3, the previous requirement for use of 1809E to disinfect utensils and equipment used to dress diseased meat carcases. While accepting that many meat establishments will continue using 180 cF water for this purpose, it recognised that others will use different means. FSIS no longer requires a specific method for the cleaning of implements used to dress diseased animals.*

3.3 Evidence supporting validation of defined conditions Preliminary experimentation has already been performed by Food Science Australia, both in the laboratory and in slaughter establishments (see Appendix 1 for the summary of this work).

The work made the following significant findings:

- 82°C water did not always remove all contamination from knives
- Most knives did not have detectable *E. coli* after rinsing in warm water
- A short contact time at 72°C could result in a greater than 3 logo reduction in *E. coli* in experimentally contaminated knives

4. Description

A three-step trial is proposed:

1. A line survey to establish contamination loadings on knives and equipment before and after 82°C treatment.
2. establishing whether water less than 82°C is effective in reducing contamination of knives and equipment to an equivalent hygienic state to that achieved by 82°C water.
3. Monitoring of hygienic quality of carcases and selected offals processed using knives and equipment that have been demonstrated to have received an equivalent treatment to 82°C water are processed.

Trials will be performed on both the beef and the sheep chains. The work will be done in three stages, at the conclusion of which a decision will be made, based on the scientific outcome, of whether to proceed to the next stage.

Stage 1: Line survey to establish contamination levels along each processing line (beef and smallstock). Prior to cleaning, and after 82°C treatment, each knife will be subjected to sponge sampling and Total Viable Count (TVC) and *E. coli* analysis. This survey will establish the loadings which typically occur on:
• Knives used for "dirty" (hide opening) and "clean" (trimming) tasks.
• Knives after 82°C treatment.
• Viscera tables on the beef and small stock chains.

The Meat Standards Committee Guidelines "Microbiolo.gical testing for process monitoring in the meat industry" (October 2002) indicate that a TVC of 5cfu/cm separates satisfactory from unsatisfactory cleaning of work surfaces. No mention is made in these Guidelines of knife decontamination.

The maximum contamination allowable on a knife prior to use will be defined as the maximum level of contamination detected on a knife cleaned according to the requirements of the Australian Standard.

Stage 2: Monitor knife cleaning using temperatures lower than 82°C
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Analysis of knives will be carried out using different knife cleaning systems. The cleaning systems will consist of various time-temperature combinations for water and procedures for freeing the knife surface of adhering contamination. When the trial is being carried out the knives will not be used on carcases without first being treated at 82°C before use. That is, the knife will be cleaned at the test temperature, then tested microbiologically before being dipped in 82°C water and used for the next carcase. Microbiological monitoring will be the same as in stage 1.

Successful treatments for each knife station will be those meeting the criterion defined in stage 1. Some stations may need to continue to use 82°C whereas others will be able to use lower temperature water as part of a cleaning system.

Stage 3: Monitoring of carcase hygiene
The knife cleaning systems defined in Stage 2 will be applied to carcases and offals being processed in routine operation. The trial will consist of an equal number of days operation on the standard and the trial procedure, alternating between the two to randomise the hygienic quality of animals being processed.

The Meat Standards Committee Guidelines "Microbiological testing for process monitoring in the meat industry" (October 2002) will be used as a basis for testing carcases and selected offals. For carcase testing, MC Herd uses an additional sampling point on the rump (similar to that used in the ESAM program operated by AQIS). The effect of knife cleaning on the bacterial loading taken onto cutting lines will also be monitored. A large number of samples will be collected each day of the trial.

The MSC Guidelines classify results on carcases as excellent, good, acceptable or marginal. Over the period 2002-2004, the results at MC Herd have been

For carcase monitorin

Category	Beef carcases n=275		Shee carcases n=184	
	TVC	*E. coli*	*TVC*	*E. coli*
Excellent	91.3%	37.0%	37.0%	22.3%
Good	8.4%	62.5%	62.5%	69.0%
Acceptable	0.4%	0.5%	0.5%	8.7%
Marginal	0%	0%	0%	0%

For offal monitoring

Category	Beef offals		Sheep ooffals n=50	
	TVC n=41	*E* coli n=62	TVC	*E. coli*
Excellent	0%	90.3%	14%	68%
Good	78%	8.1 %	50%	18%
Acceptable	22%	1.6%	32%	14%
Marginal	0%	0%	4%	0%

The *E* coli data wilt be used to monitor the trial with the criteria for acceptance of the trial being: For carcases:

	Beef	Sheep
Excellent	45% minimum	
Good		45% minimum
Acceptable	50 % maximum	50 % maximum
Marginal	5 % maximum	5 % maximum

For offals:

	Beef offals	Sheep offals
Excellent	45% minimum	
Good		45% minimum
Acceptable	50 % maximum	50 % maximum
Marginal	5 % maximum	5 % maximum

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5. **Hazard Analysis** In making this application to undertake a trial as a prelude to introducing a technique different from those detailed in the Australian Standard, MC Herd note that under "Equivalence" on page (vi) of the Standard that "The submission must include a HACCP Plan which ensures that equivalence is maintained."

In response to this requirement, MC Herd make the following observations:

1. It is standard practice for all slaughter establishments in Australia to not include knife cleaning within the HACCP plan but as a Good Manufacturing Practice (GMP).
2. At the beginning of each section of the MC Herd Food Safety Plan it is stipulated that 82°C water will be supplied as part of the company's GMPs.

Operational Hygiene Requirements Knives and implements used when processing are sterilised between each carcase in 82°C water. All equipment including steels and pouches used in processing shall be washed and sterilised regularly and whenever chance contamination has occurred. Operative's forearms and hands shall be washed regularly or when contaminated to prevent contamination between carcases.

3. To the company's knowledge, the use of 82°C water has never been validated against any scientific criteria.
4. In cooperation with Meat and Livestock Australia we propose to undertake such validation and to establish criteria for knife cleaning against which alternative procedures can be compared.
5. Accordingly we will seek to validate an alternate system under Section 20.5c of the Australian Standard namely that facilities for cleaning and sanitising implements: "are provided with an adequate supply of hot potable water at no les than 82°C or an equivalent method of sanitising."

6. Performance Standard

6.1 Criteria for proceeding from Stage 2 to Stage 3

- Scientific confirmation of cleaning systems using temperature(s) cooler than 82°C give cleaning equivalent to the current dip in 82°C water.
- The maximum contamination allowable on a knife prior to use will be defined as the maximum level of contamination detected on a knife cleaned according to the requirements of the Australian Standard.
- The maximum contamination allowable on the viscera tables prior to use will be defined as the maximum level of contamination detected on viscera tables cleaned according to the requirements of the Australian Standard.

Also monitored will be:

- Temperatures of knife cleaning baths using data loggers
- Evidence of abnormal accumulation of meat tissue and hair in the baths
- Evidence of malfunction of the ball flow control valves through accelerated scale build-up, and consequent reduction or cessation of hot water flow

Where monitoring indicates non-compliance the corrective action will be to:
(a) seek assistance of a slaughter floor supervisor to assist the operator modify the procedure to ensure adequate immersion times or, if this is not possible,
(b) immediately raise the water temperature in the noncompliant steriliser by opening the hot water flow valve.

6.2 Criteria for proceeding from Stage 3 to in-plant adoption
Scientific confirmation that carcase hygienic quality meets the Guidelines set by Meat Standards Committee using the modified cleaning system.

7. Methodology Stage 1: Line surveys Knives and viscera tables will be sponged and analysed for TVC and E. coli/cmz of surface. At least two line surveys will be carried out along both beef and smallstock slaughtering lines.

Stage 2: Establish cleaning effectiveness of different temperature regimes Off-line sterilisers will be adjusted to temperatures identified as being capable of removing/inactivating contaminants on knives at the selected work stations. Analysis of cleaned knives will be undertaken on at least two occasions and comparison made with knives cleaned by the current regime. Item 5.1.3 - Standards - alternative compliance for equipment sanitising; application by MC Herd Meat Standards Committee, Sydney, 2 March 2005

Stage 3: **Monitoring of Carcase and Offal Hygiene** During the trials careful monitoring of knife cleaning procedures and temperatures will be conducted. Enhanced testing of carcases and offals will be undertaken and compared with the long-term trend analysis graphs used by MC Herd to evaluate ongoing slaughter hygiene. Additional tests along cutting lines will be conducted. The trial results will be monitored as they become available and the trial will be suspended if results exceeding the success criteria are obtained.

APPENDIX 1

Summary of the Research Report
'Investigation of alternatives to 82OC water for knife and equipment sterilisation'

Ian Eustace and Jocelyn Midgley (2003) *Final* Report Project *PRMS.037* for: Meat & Livestock Australia

For many years, Australian abattoirs - export-registered and domestic alike - have been required to have facilities for cleaning and sanitising knives and other implements that are provided with an adequate supply of hot potable water at no less than 82°C. However over the past three years, Australian Standard 4696:2002 and various overseas documents specify that alternative systems having a disinfection effect equivalent to 82°C water can be used in lieu.

Knife and equipment sterilisers use large volumes of hot water, creating water supply and disposal problems, high energy costs and operator safety concerns. There would be a number of benefits to abattoirs if the demand for 82°C water can be reduced.

This document outlines current regulatory requirements, the historical reasons for using 82°C water and relevant scientific literature. Some alternative but equivalent procedures to 82°C water were identified and investigated in a series of laboratory and in-plant trials.

The focus of laboratory investigations was to investigate the ability of water to reduce the numbers of test bacteria *(E. coh)* on blades of knives. The treatments investigated included cleaning knives under lukewarm hand-wash water, immersion in hot water at various temperatures for various times, and low-power ultrasound to complement the hot water.

Procedures were developed to cover blades with preparations of fat or mince spiked with *E. coli* at levels around 10' per gram. These knives were used in laboratory studies that showed that immersion of knives in hot water for up to 30 seconds was necessary to achieve, reliably, reductions in numbers of *E. coli* of more than 4 log units. Immersion of knives for 10 seconds in water at 72°C, 75°C, or 82°C reliably achieved reductions of 3 log units or better.

Use of an ultrasonic knife cleaner did not improve the ability of hot water to inactivate *E, coli* on contaminated knives and it is recommended that it not be investigated further.

In-plant investigations at a domestic abattoir indicated, predictably, that knives used for some dressing operations on the slaughter floor are more contaminated than other knives. Knives used for legging and for dressing heads yielded more bacteria than the knives used for evisceration and fat trimming operations although the numbers of bacteria were consistently low. Rinsing the knives under streams of wash-water removed at least 70% of the bacteria, leaving very low numbers of *E. coli* and other bacteria. Data from an export abattoir and the domestic one showed low contamination on knives after pre-washing. E coli was not detected on 108 of 142 knives sampled after rinsing in wash-water, and 91 % of the knives had total bacterial counts of less than 1000/cmz. Treatment of the knives with hot water (momentary immersion at 82°C or 15 s at 72°C) further reduced the numbers, usually to undetectable levels in the case of *E. coli.*

A major incentive to use hot water at a temperature lower than 82°C where adequate immersion times are practical is the opportunity to dramatically reduce the quantity of water used for disinfection. Trials at the domestic abattoir showed that hot water consumption for disinfection purposes on the slaughter floor could be more than halved from the current 320 kL per week if the knife steriliser baths could be held at a minimum 72°C instead of 82°C. The ball valves currently used on most knife steriliser baths for flow control are, however, too difficult to use to adjust the flow rates and, duly, the temperature of the water in the baths. Installation of needle valves in series with ball valves permits more precise control of hot water flow and steriliser temperatures.

The pre-washing of knives, which should precede hot water disinfection, would have to be carried out consistently so that an excessive build-up of hair and meat particles in the baths does not occur.

It is recommended that AQIS be encouraged to permit in-plant trials in one or more large export abattoirs so that the benefits and drawbacks of using steriliser temperatures lower than 82°C can be further investigated.

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