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Prepared by:	Craig Andrew-Kabilafkas Australian Food Microbiology
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Meat and Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Improved Abattoir Hygiene through Simplified and Improved Practices

Using Hygienic Design Guidelines and Water Management for Better Red Meat Processing in Australia

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Abstract

This guidance document for the Australian Red Meat Industry reviews current developments in cleanability and hygienic design with the aim of supporting the red meat industry in reducing water used for cleaning and reducing labour costs associated with cleaning.

The report examines simplified and improved practices for improving abattoir hygiene through water savings and water use efficiencies focussing on slaughter and boning rooms. It also reviews hygienic design and the opportunities and issues in implementing hygienic design into Australian red meat facilities.

Worked examples and case studies are used to illustrate the application of water auditing tools, cleaning and disinfection plans, sanitising chemicals, procedures and applications and hygienic design principles and applications.

Executive Summary

To support the Australian Red Meat Industry in finding efficiencies through cleanability and hygienic design, this project examined current developments and strategies in abattoir water efficiency and hygienic design.

This report reviews the procedure for implementing changes into organisations which will precede the process of implementing a water and hygienic design strategy. The report presents data illustrating the economic benefits of improved water efficiency and defines cleanability. An explanation of the different chemicals used in cleaning, their applications and efficacy is summarised. The implication of water quality on cleaning is also discussed.

There is included a step-by-step procedure for identifying water saving opportunities including case studies where abattoirs have achieved water savings through assessment of their operations. Summary data on water consumption and use in typical Australian abattoir operations are included to assist abattoirs benchmark their processes against industry standards.

An explanation of hygienic design and the process for assessing hygienic design both at a plant level and at an individual piece of equipment is included. The procedure for measuring hygienic design and the costs of poor hygienic design are discussed.

A decision to change water consumption or to apply hygienic design principles has to be made within the context of Australian food regulations. These regulations are summarised to assist readers in identifying understanding the regulatory framework that will guide or limit change, including food safety that are used to measure cleanliness in abattoirs.

This report is complemented by a separate literature review.

Contents

1 Introduction

Hygiene in the meat industry is an underpinning obligation that assures meat is safe for human consumption. Businesses that are unable to ensure hygienic standards of production are liable to contaminate their production and threaten the viability of their business and the meat industry.

While the costs of maintaining high standards of hygiene seem to be ever increasing, there are ways to improve hygiene and reduce costs. For the modern Australian abattoir there is the potential to improve profits by reducing inefficient operational costs.

This paper explores current developments in the meat industry where costs are being better controlled through improved hygienic practices. In particular we examine the cost savings that can be achieved through better use of water resources and hygienic design.

2 Improving Abattoir Hygiene through Simplified and Improved Practices

2.1 Creating Enthusiasm for Change

When faced with change, many managers will ask "why do I need to change?" and challenge "If it ain't broke, don't fix it". Clearly there needs to be a reason for change and a measurable benefit before management will condone and support investing in a change to existing operations. The willingness to embark on a program of change may be triggered by a "carrot and stick" approach, the stick being regulations or trade restrictions and the carrot being increased profits and rewards. Indirectly this may also be through political, environmental and social drivers.

Basic investment in good hygiene practices is a regulatory requirement that is equally applicable across the entire food industry. The meat industry has specific expectations that will depend upon if you are supplying export or domestic markets. If the cost of achieving these regulatory requirements is measured and analysed, then it is possible to properly assess the allocation of resources to achieve the most efficient operation. There are Australian meat processors who have assessed the efficiency of their hygiene practices and have been able to gain a more efficient operation. Some of these examples are listed as case studies throughout this report. These businesses have been able to realise a competitive advantage over businesses that have not yet taken the time and effort to assess the efficiency of their hygiene practices.

Any meat processor can use the following simple hygiene improvement assessment procedures to find cost reduction opportunities in rates of water consumption and in the costs of factory cleaning and hygiene.

Case Study 1: Capture and Reuse of Boning Room Knife Steriliser Water

A study was conducted at Abattoir A to assess the suitability of water from the Boning Room knife steriliser units for reuse in the additional applications of washing down waste water contra-shears and for washing down outside of the rendering plant. The contra-screen used a potable water cleaning system to reduce the rate of build-up of solids on the screen. Potable water was also used for wash down of the outside of the rendering plant.

The knife steriliser water was analysed and found to have low levels of microbes. To store and heat this reuse water, a holding tank was installed and steam injection was used to heat the water. The heat process negated the residual microbial load in the reuse water.

The project was successfully implemented and resulted in a saving of **100KL** potable water per day.

2.2 Water Efficiency

Abattoir water consumption has been identified as one of the top three environmental issues associated with abattoir operations (Genne & Derden, 2008). Water is primarily consumed in cleaning and washing activities. Mapping water consumption is the first step in understanding where water is consumed, the quality of the water used and then where water conservation can be achieved.

The allocation of water to specific section and task varies dependent upon the animal being processed, the numbers of animals processed, the method of slaughtering, the processes used and the extent of automation. The combined need for water at different temperatures, from 4˚C for cooling up to 90˚C for scalding, is a major contributor to the energy consumption in the facility.

Estimates of water consumption per slaughtered animal in the EU has been calculated and broken down into specific processing steps (Tables 2.2.1. & 2.2.2). These data have been calculated and measured through the construction of a water balance in which the percentage allocation of total water consumption to different water consuming processes is measured. The process involves generating data from:

- Process specifications
- Meter readings and
- Flow measurements

For Australian medium to large integrated export meat processing plants, best practice in water usage is 5 – 7 kL water / tonne HSCW (MLA, 2013).

Table 2.2.1 Estimated Water Consumption for Pigs & Beef Cattle (Litres per slaughtered animal)

Process Step	***Pig***	***Beef***
Animal Reception & Lairage	16-45	176-250
Stunning & Bleeding	3.1-6.8	
Hide & Skin Removal		2.5
Scalding & Singeing	50-72.5	
Processing of the entrails/carcass splitting	34-52	
Stomach Rinsing		250-1,380
Cooling	0-17.3	
Cleaning activities	25	
Total	**123-703**	**400-4,500**

(Genne & Derden, 2008)

In this example the total annual consumption of water for the pig abattoir was measured at 85,000m^3, which was equivalent to an annual water consumption of 106L per slaughtered pig. More detailed water consumption tables for this example are included in the Appendices.

Table 2.2.2 Breakdown of Water Consumption

Australian Survey Data		***Danish Survey Data***		
Purpose	***General***	***Purpose***	***Pig***	***Cattle***
Stockyard wash downs and stock watering	7-22%	Livestock receipt and holding	8%	22%
Slaughter evisceration and boning	44-60%	Slaughter	32%	28%
Casings processing	9-20%	Casings processing	24%	21%
Inedible and edible offal processing	7-38%	Scalding (pigs)	3%	NA
Rendering	2-8%	Hair removal (pigs)	8%	NA
Domestic-type uses	2-5%	Dressing (cattle)	NA	22%
Chillers	2%	Cleaning	25%	7%
Boiler losses	1-4%			

(UN Environment Programme & Danish Environmental Protection Agency, 2000)

Additional estimates on overall water consumption have been calculated for different species (Table 2.2.3) and countries (Table 2.2.4).

Table 2.2.3 Total Water Consumption for Pigs, Beef & Sheep

Animal	***Litres per Tonne of Animal Carcass***
Pig	1,600 - 8,300
Cattle	1,623 - 9,000
Sheep	5,556 - 8,333
Poultry	5,070 - 67,400

(EIPPCB, 2005)

Table 2.2.4 Water Consumption per Unit of Production

Country	m^3/t LCW	m^3/t HSCW	m^3/t meat	L/head
US (1984)	4.2-16.7			
UK (1980)	5-15			
Europe (1979)	5-10			
Hungary (1992)	2-3.8			
Germany (1992)	0.8-6.2			
Australia (1995)		4-12		
Australia (1998)		6-15		
Denmark (pigs)			5-20	225
Denmark (cattle)			4-17	860

(UN Environment Programme & Danish Environmental Protection Agency, 2000)

2.2.1 Water Usage Costs

The true cost of using water can be calculated using the following calculations considering both the true costs of the incoming water and the reduction in costs associated with treatment of wastewater

Water cost savings = W_{Saved} x (W_{Rate} + W_{Treat})
Where: W_{Saved} is the volume of water saved
W_{Rate} is the incoming water rate (e.g. $/$m^3$)
W_{Treat} is the treatment cost of the incoming water
Wastewater treatment charge = WW_{Saved} x WW_{Charge}
Where: WW_{Saved} is the volume of wastewater saved
WW_{Charge} is the volumetric wastewater charge including costs of parameters such as COD (chemical oxygen demand), BOD (biological oxygen demand), total solid content, etc.
Work in Queensland has estimated that the true cost of water can be up to $2.00 per kL, which makes a significant change to any assessment when compared to the retail costs used in some studies of $1.10 per kL.

Case Study 2: Assessment of the Suitability for Reuse of Boning Room Effluent

A study was conducted at Abattoir C to measure and assess the suitability of boning room effluent for reuse. The waste streams identified for assessment included:

- Air conditioner evaporative coolers
- Boning room sterilisers
- Evaporators at the Variable retention tunnel and
- Refrigeration condensers

It was recognised that the value of the water savings would have to exceed the costs of installation of plumbing to divert the water, the costs of water treatment in the case of high microbial loads and the cost of installation of static screens to capture solids. The only likely stream that provided sufficient volume of water to be potentially viable was the boning room sterilisers. The potential water saving was calculated at 18kL per day. At the current cost of $1.10 per kL, the cost saving of approximately $20 per day was considered insufficient to cover the cost of plumbing to divert water into other uses. The data from this assessment is readily available should costs change or additional opportunities emerge.

(MLA, 2013)

2.2.2 Water Auditing

Water audits are relatively simple and are based on the principles of continuous improvement. An outline of the water audit procedures are summarised below:

1) Management Commitment
    - Ensure Top Management Support
    - Set Goals to be Achieved
    - Get Employee Participation
    - Identify Key Roles (Conservation Manager)
2) Establish a Factory Water Conservation Team
3) Conduct a Water Audit
    - Scope to include process water, cooling water, water for steam generation and floor and equipment wash water
    - Review and assess process flow diagrams for type and amount of water consumed
    - Collect data including:
        - Total annual monthly water consumption for the entire facility
        - Monthly water consumption for each plant
        - Raw material consumption and annual consumption rate for various products
        - Number and capacity of boilers
        - Number and capacity of cooling towers
        - The presence of barometric leg condensers
        - Factory sewer lines
        - Segregation/integration of different types of water
        - Washing/rinsing procedure
        - Maintenance of pipes and fittings
        - Wastewater quality
        - Quality of consumed water (well water, softened water, de-ionised water, drinking water)
4) Identify water saving opportunities
    - Assessment of the data will allow a cost benefit assessment to be completed and an implementation plan. Payback time and cost saving are the primary criteria for deciding which strategies to employ.
5) Evaluate the expected water savings
    - The following steps can be used to evaluate the savings achieved through the steps implemented
        - Water flow rate is measured using flow meters
        - Measurements are taken at the same time over a period of 1 month and several times per day
        - Maximum, minimum and daily average for water consumption is calculated
        - The amount of water saved by implementing the measure is calculated and the cost of water saved
        - Cost savings are estimated based on current production rates and on estimated maximum production
        - The cost of the measure is estimated and the cost benefit calculated

An eco-efficiency self-assessment guide that includes identification and measurement of water, energy, chemicals, packaging, waste and other measures is available through the MLA Eco-Efficiency Manual for Meat Processors.

2.3 Cleanability

The European Hygienic Engineering and Design Group (EHEDG) define the term “Cleanability” as “the suitability of equipment to be freed from soil easily”.

AS4709:2001 is a guide to cleaning and sanitising of plant and equipment in the food industry. It provides a definition of a “**Clean surface**” as:

- A surface that is free from soil and complying with the following characteristics:
    a. Contamination or oxidation is not visible under good lighting when the surface is dry
    b. No objectionable odour is discernible
    c. The surface does not feel greasy when rubbed with clean fingers

It also provides the definition of a “**Sanitised clean surface**” as:

- A clean surface (as described above) that is substantially free from pathogenic microorganisms and undesirable numbers of spoilage
- organisms following the application of a sanitiser

The ability of cleaners to achieve a *clean* surface and a *sanitised clean* surface is affected by the nature of the surfaces being cleaned. The surface material and the condition of that material will influence effort and ease needed by the cleaning mechanism to release soil and achieve a clean surface. These considerations will be site and plant specific and cannot be standardised across the industry.

The following points can improve knowledge and achieve improved hygienic status on open surfaces:

- Inspect for the presence of visible food residues – these are the areas where the cleaners are struggling and are costing you through follow-up corrective actions,
- Identify critical areas – these must be consistently, properly cleaned. Poor cleaning can cause a critical food hygiene failure that will affect the safety and quality of your product,
- Understand key microbiology concepts and terms and the relevance to your plant, including the implications of:
    a. Resident bacteria – those bacteria that survive and thrive in your facility
    b. Persistence – how and why microbes are not easy to remove from your facility
    c. Choice of cleaning and disinfection protocols – the combinations and application procedures of detergents and disinfectants that are most effective for your facility,
- Select methods to detect “invisible” biofilm and food residues on surfaces,
- Remember that food soil may be harder to remove than microbial cells, and can affect the subsequent hygienic status,
- Identify the effectiveness and limitations of a selected cleaning method for use specifically in the meat industry
- If assessing a hygiene system through laboratory studies, ensure that the microbiologist is able to design an appropriate program that considers:
    a. Strain selection and resident strains
    b. Growth (biofilm) or survival (immobilised)
    c. Presence and nature of food soil
    d. Impact of repeated soiling and cleaning

2.4 Water Quality

Water quality is crucial in ensuring thorough cleaning and sanitising. Water serves the crucial functions of:

- Pre-rinsing to dislodge and carry away debris left after processing has been completed
- Softening soils left over on the surfaces
- Carrying detergents to the soiled surface
- Carrying waste and soil away from the surface
- Diluting the detergent off the surface
- Carrying disinfectant to the cleaned surface
- Diluting the disinfectant off the surface

As water is in intimate contact with food contact surfaces, the water used for cleaning food contact surfaces must be potable. If the water is not potable then impurities in the water can contaminate the food contact surface and may neutralise the efficacy of the disinfectant. The Australian Drinking Water Guidelines (ADWG) details the limits of various chemical and microbiological quality parameters for drinking water. Potable water is defined in the Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption, as water that is consistent with the ADWG. Significantly, the ADWG notes the following microbiological quality guideline:

- *Escherichia coli* count for packaged water must be less than 100/mL

Microbiological limits for ice used in food production are described in the Food Standards Code (FSANZ, 2012) and similarly notes that the:

- *Escherichia coli* count for packaged water must be less than 100/mL

In the FSANZ User Guide to Standard 1.6.1 the following guidelines for packaged water and ice are also listed:

- Standard Plate Count must be less than 100/mL and
- *Pseudomonas aeruginosa* must be absent in 250mL

2.5 Efficacy of Cleaning Agents

There is a wide range of cleaning and sanitising chemicals marketed for use in the meat industry. No one chemical suits all applications and it is often the combination of detergent and disinfectant in a sanitiser, or the alternating of chemical treatments between routine and periodic cleaning schedules that is most effective in controlling food residue build up, biofilms and the survival of resistant microbes.

Tables 2.5.1 & Table 2.5.2 below detail the applications and relative advantages and disadvantages of different chemical disinfectants. There are some agencies that assess and provide reports on the efficacy of disinfectants including:

- German Disinfectants Commission in the Association for Applied Hygiene (VAH) (see www.vah-online.de) which publishes an inventory of all disinfectant products showing their active ingredients, contact times & use concentrations
- Health Canada assessment of Disinfectant Drugs (see http://www.hc-sc.gc.ca/dhp-mps/prodpharma/applic-demande/guide-ld/disinfect-desinfect/disinf_desinf-eng.php) which provides safety & efficacy guidelines for hard surface disinfectants, disinfectant-sanitisers & food contact sanitisers

The efficacy of the three main groups of disinfectants has been summarised in Table 2.5.3.

Table 2.5.1 Chemical Disinfectants and their properties and applications in the food industry

Disinfectant	Area of Application	Advantages	Disadvantages
Acid Anionics	Food contact surfaces, environmental surfaces	Stable, long shelf-life Non-corrosive Non-staining Low odour Not affected by hard water Removes mineral films	High cost pH sensitive (optimum pH 2-3) Poor yeast and mould activity High foaming Skin irritant Inactivated by cationic surfactants
Alcohols e.g. ethanol or isopropanol	Food contact surfaces that need to be dry after application, hand hygiene products	Broad spectrum of activity Used on water sensitive equipment Mid-shift cleaning in high risk areas Quick drying No residue Non-staining, non-corrosive	Not effective against spores Inactivated by organic material Flammable Expensive Evaporation may diminish the concentration Limited activity range (60-80% in water)
Amphoterics	Food contact surfaces, environmental surfaces, fogging, hand hygiene products	Broad spectrum of activity Non toxic, odourless, colourless Non corrosive No rinse capability	Not effective against spores Inactivated by high soil levels Excessive foaming in mechanical applications Expensive
Biguanides	Food contact surfaces, environmental surfaces, hand hygiene products	Broad spectrum of activity Non toxic, odourless, colourless Non corrosive No rinse capability	Not effective against spores Activity limited to specific pH range Not hard water tolerant
Chlorine based chemicals e.g. sodium hypochlorite and slow releasing chloramines	Water supplies, food contact surfaces, environmental surfaces,	Broad spectrum of activity Hard water tolerant Break down organic residues	Risk of gas release when mixed with acids Corrosive to metals Irritant to skin and mucous membranes

Disinfectant	Area of Application	Advantages	Disadvantages
	CIP	Low temperature efficacy Effective at low concentrations Relatively inexpensive Fast acting	Strong odour causing taint issues Unstable, short shelf-life Readily inactivated by organic material and some detergent residues
Chlorine dioxide	Water supplies, food contact surfaces, environmental surfaces, udder treatment in milking parlours	Wide spectrum of activity including spores Low concentration Rapid action Less interaction with organic matter than chlorine	Cost of specialised generation equipment Low soil tolerance Sensitive to light and temperature Toxicity Corrosive Offensive odour Risk of gas release
Gluteraldehyde	Gaseous form used for fumigating poultry houses, agricultural environment, food contact surfaces when mixed with e.g. QAC's	Broad spectrum and sporicidal Non corrosive to metals Active in presence of organic material Can be used in the liquid or gaseous form	Extremely irritating and toxic to skin and mucous membranes Instability High cost
Hydrogen peroxide	Food contact surfaces, environmental surfaces, egg hatching environments	Wide spectrum of activity including spores Fast acting Low toxicity – breaks down into water and oxygen Non-corrosive Non-foaming	Not hard water tolerant Activity limited to a specific pH range Corrosive to aluminium, copper, brass and zinc Taint
Iodine based chemicals e.g. iodophores and aqueous iodine	Agricultural environment, udder and teat treatment, fogging, hand hygiene	Broad spectrum of activity Low toxicity Effective pH range 2 to 8	Strong odour causing taint issues Staining porous and plastic materials Poor at low temperatures

Disinfectant	Area of Application	Advantages	Disadvantages
		Stable long shelf-life	Corrosive at high temperatures Inactivated by organic materials Expensive
Peracetic acid	Food contact surfaces, environmental surfaces, CIP	Broad spectrum of activity including spores Rapid action Low concentration required Low foaming Non-rinse status	Pungent odour Corrosive to soft metals Can bleach food surfaces Unstable when diluted
Quaternary ammonium compounds	Food contact surfaces, environmental surfaces, fogging	Non-toxic, odourless, colourless, Non-corrosive Temperature stable Some detergency and soil penetrating ability Stable, long shelf-life Broad spectrum of activity Mould and odour control Can have residual effect “No rinse” capability	Incompatible with anionic detergent foam Sensitive to organic soils Not effective against spores Corrosive at high concentrations Low hard water tolerance Limited low temperature activity Excessive foaming in mechanical applications

Source: (Middleton, 2008)

Table 2.5.2 Non-Chemical Disinfectants and their properties and applications in the food industry

Non-Chemical Disinfectant	Area of Application	Advantages	Disadvantages
Heat e.g. hot water or steam	A shorter time exposure requires a higher temperature. Volume of water and flow rate will also influence the time taken to reach the required temperature	Broad spectrum efficacy Non-corrosive Penetrates into surfaces Leaves no residues	Expensive unless steam plant in-house Time and cooling Damage Condensation formation Health and safety
Irradiation e.g. UV or gamma rays	Dose is a combination of intensity and time Dust, thin films of grease, and opaque or turbid solutions can absorb them	Non-taint Low toxicity Wide spectrum Non-corrosive	Set-up cost Shadowing Maintenance costs No residual effect
Vapourised/vapour phase hydrogen peroxide	Powerful oxidising agent as a vapour for room disinfection	Broad spectrum efficacy Leaves no residues Decomposes into oxygen and water Ability to penetrate areas inaccessible to chemical fogs Non-corrosive	Cost of specialist equipment Health and safety Unstable Humidity sensitive
Ozone	Powerful oxidising agent as a gas for room disinfection	Broad spectrum of activity Total saturation Natural product Ability to penetrate areas inaccessible to chemical fogs	Cost of specialist equipment Health and safety (free radicals) Unstable Humidity sensitive Corrosive

Source: (Middleton & Holah 2008)

Table 2.5.3 Characteristics of three main groups of disinfectants and other procedures

Microbial Control and Property	Chlorine	Hydrogen Peroxide	Quaternary Ammonium Compounds	Hot water (>82°C)	Water + lactic acid
Gram positive bacteria	++	++	++	++	++
Gram negative bacteria	++	++	+	++	++
Spores	+	++	-	-	?
Fungi	++	++	++	+	+
Inactivation by organic matter	++	+	+	+	+
Inactivation by water hardness	-	-	+	-	+
Detergency	-	-	++	+	+
Foaming potential	-	-	++	-	-
Rinsability	++	++	-	++	++
Workers safety	+	++	-	++	++
Cost	-	+	++	-	-

Source: (Brooke-Taylor & Co Pty, 2005)

++ = large effect + = effect - = no effect ? = no scientific evidence

2.5.1 Facility Cleaning & Decontamination

It is well known that poor surface hygiene will directly affect the quality and safety of the food that comes into contact with that surface. Microbes that survive on the surface can be protected within biofilms and can be readily transferred from the surface to the food via air, personnel and cleaning systems.

As cleaning consumes significant amounts of water in abattoirs, any means of reducing consumption whilst maintaining hygiene standards is desirable.

The process of facility cleaning is influenced by the nature of the food, the condition of the soiled surface, accessibility to the soil and the tools available for use in cleaning.

The typical sequence of a routine cleaning procedure is:

- Preparation
- Pre-rinse
- Detergent cleaning
- Intermediate rinse
- Visual check
- Moisture removal
- Sanitise
- Post rinse
- Draining/drying
- Pre-production rinse
- Documentation

The quantity of water and other resources used, such as labour, chemicals and energy, can be significantly reduced by using a combined detergent/sanitiser which can remove the intermediate rinse and moisture removal steps.

The removal of steps from the cleaning sequence must be considered in the context of the purpose of the step and the quantity of water, and other resources, used in that step. One estimate is that fresh water rinsing of about 8 litres per square metre should be adequate to remove disinfection residues if the cleaning/disinfection procedure is performed correctly. If steps are not performed correctly then the quantity of water used will increase.

“Routine” cleaning procedures and “Periodic” cleaning procedures require different combinations of chemicals and applications.

“Routine” cleaning procedures are applied each time a process is completed. “Periodic” cleaning occurs at less frequent intervals (e.g. weekly, monthly or annually) and may be structured to remove longer term accumulations of food materials that occur over extended periods of time. Periodic cleaning can be scheduled to ensure that non-food contact areas are regularly cleaned or that equipment is appropriately cleaned and sanitised after routine servicing. Reviewing the inclusion of equipment or sections into either routine or periodic cleaning schedules can assist in water saving efforts.

The choice of chemical used in the cleaning process will also influence the efficacy of the cleaning process as well as the quantity and quality of water used in the process. Table 2.5.1 shows the impact of different water impurities on equipment.

Table 2.5.1: Water Impurities and Associated Problems

Impurity	*Problem Caused*
Common Impurity	
Oxygen	Corrosion
Carbon Dioxide	Corrosion
Bicarbonates (Sodium, Calcium or Magnesium)	Scale
Chlorides or Sulphates (Sodium, Calcium or Magnesium)	Scale & Corrosion
Silica	Scale
Suspended Solids	Corrosion & Deposition
Unusually high pH (above 8.5)	Mediate Corrosion or Depositions; Alter detergent efficiency
Unusually low pH (below 5)	Mediate Corrosion or Depositions; Alter detergent efficiency
Less Common Impurities	
Iron	Filming and Staining
Manganese	Corrosion
Copper	Filming and Staining

(Schmidt, 2009)

Table 2.5.2 details some of the chemical characteristics of different types of food soils, their solubility, ease of removal and the impact that heat has upon the soil. Table 2.5.3 compares chemical and physical properties of sanitisers commonly used across the food industry.

Table 2.5.2: Characteristics of Food Soils

Surface Deposit	*Solubility*	*Ease of Removal*	*Heat-Induced Reactions*
Sugar	Water soluble	Easy	Carmelisation
Fat	Alkali soluble	Difficult	Polymerisation
Protein	Alkali soluble	Very difficult	Denaturation
Starch	Water soluble - Alkali soluble	Easy to moderately easy	Interaction with other constituents
Monovalent Salts e.g. Sodium chloride	Water soluble – Acid soluble	Easy to difficult	Generally not significant
Polyvalent Salts e.g. Calcium chloride	Acid soluble	Difficult	Interaction with other constituents

(Schmidt, 2009)

Table 2.5.3: Comparison of the Chemical and Physical Properties in Commonly Used Sanitisers*

	Chlorine	***Iodophors***	***Quaternary Ammonium Compounds***	***Acid anionic***	***Fatty Acid***	***Peroxyacetic acid***
Corrosive	Corrosive	Slightly corrosive	Non corrosive	Slightly corrosive	Slightly corrosive	Slightly corrosive
Irritating to skin	Irritating	Not irritating	Not irritating	Slightly irritating	Slightly irritating	Not irritating
Effective at neutral pH	Yes	Depends on type	In most cases	No	No	Yes
Effective at acid pH	Yes, but unstable	Yes	In some cases	Yes, below 3.0-3.5	Yes, below 3.5-4.0	Yes
Effective at alkaline pH	Yes, but less than at neutral pH	No	In most cases	No	No	Less effective
Affected by organic material	Yes	Moderately	Moderately	Moderately	Partially	Partially
Affected by water hardness	No	Slightly	Yes	Slightly	Slightly	Slightly
Residual antimicrobial activity	None	Moderate	Yes	Yes	Yes	None
Cost	Low	High	Moderate	Moderate	Moderate	Moderate
Incompatibilities	Acid solutions, phenols, amines	Highly alkaline detergents	Anionic wetting agents, soaps and acids	Cationic surfactants and alkaline detergents	Cationic surfactants and alkaline detergents	Reducing agents, metal ions, strong alkalis
Stability of use solution	Dissipates rapidly	Dissipates slowly	Stable	Stable	Stable	Dissipates slowly
Maximum level permitted by FDA without rinse	200ppm	25ppm	200ppm	Varied	Varied	100-200ppm
Water temperature sensitivity	None	High	Moderate	Moderate	Moderate	None
Foam level	None	Low	Moderate	Low/Moderate	Low	None
Phosphate	None	High	None	High	Moderate	None
Soil load tolerance	None	Low	High	Low	Low	Low
* Comparisons made at “no-rinse” use levels						

(Schmidt, 2009)

When considering which cleaning chemicals suit your needs, you need to consider the best combination of chemicals for routine and periodic cleaning. Table 2.5.4 details an example of a Cleaning and Disinfection plan, illustrating the switching between alkali and acid cleaning to minimise any build-up of food soiling.

Table 2.5.4: Example Cleaning and Disinfection Plan

Equipment: Meat grinder

Pre-cleaning	Potable water Temp.: 40-50°C Pressure: 20-30 bars	
Cleaning	Daily Agent: A Concentration: 1.0% Temp.: 40-50°C Time: 20-30 min pH: approx. 12	1 x monthly Agent: B Concentration: 1.5% Temp.: 40-50°C Time: 20-30 min pH: approx. 1.8
Rinsing	Potable water Temp.: 30-50°C Pressure: 5-10 bars	
Drying		
Disinfection	2 x weekly Agent: C Concentration: 0.5% Temp.: 30-40°C Time: 30 min pH: approx. 5.7	3 x weekly Agent: D Concentration: 1.0% Temp.: 30-40°C Time: 30 min pH: approx. 10.2
Rinsing	Potable water Temp.: 30-50°C Pressure: 5-10 bars	

Agent **A**: Alkaline cleaning substance
Agent **B**: Acid cleaning substance
Agent **C**: Disinfectant
Agent **D**: Disinfectant chemically different from C and supplementing impact of C (FAO)

There are four resource inputs involved in any sanitation program (chemical energy, mechanical/kinetic energy, temperature/thermal energy and time). Water is used in transporting two of these inputs (mechanical/kinetic energy, temperature/thermal energy) to the site being cleaned.

Water is used to transport chemicals (detergents and disinfectants) and to dilute chemical residues. However water is also the primary media needed for microbes to survive and grow in the food production facility. Letting water remain in the factory environment after cleaning will help microbial biofilms quickly regenerate.

Biofilms are significant as they can protect and enhance the growth of pathogens, such as *E. coli* O157:H7, in the factory environment. Crevices and hidden surfaces, within the facility or equipment, become a ready “locus of contamination”; a place where they are protected and allowed to grow unchecked. As they grow, they create the biofilms which provide additional protection for the microbes and help the long term survival of the microbial colony. Within the protection of the biofilm there is potential for survival of strains that have increased resistance to antimicrobial agents, such as disinfectants as well as microbes with the ability to survive in the presence of low nutrients.

Packaging machines, conveyers, dispensers, slicing machines and cooling machines are the most problematic equipment to keep clean. This is understandable due to the complexity of the equipment, the potential OH&S hazards that present to the cleaning staff (i.e. rotating blades and moving parts) and the difficulty in accessing parts of the machinery.

Water can be removed “passively” by using of water repellent surfaces, or design features that help disperse water off the surfaces. Passive water removal is preferable to “active” moisture removal which consumes more energy. Simple moisture removal strategies include wiping dry, squeegee and inverting equipment.

Hygienic design and operation may not have been a priority for some equipment manufacturers; however this may change as the EU Machine Directive (89/392/EEC, revised 98/37/EC) requires manufacturers to provide instructions for cleaning equipment. The Directive does not specify what kinds of instructions have to be included and so may be end up being of limited use to the end user.

Equipment manufacturers who do not have detailed and technical knowledge of cleaning procedures, chemical and tools need to write instructions in cooperation with cleaning specialists to ensure useful information is available for the end user. Cooperation on hygiene aspects between equipment and sanitizing agent manufacturers and food processors at the design phase of the equipment can help to prevent and eliminate hygiene issues.

The conditioning of food contact surfaces with food residues (e.g. meat and fat soil) can stimulate microbes to attach to the surface. There is now the technology available to conduct chemical and physical analysis of food deposits on surfaces to develop a better understanding of the forces and chemicals needed to remove specific food residues.

The two step processes of cleaning and disinfection has been assessed to determine the reduction in microbes that occurs at each of the two steps and showed that the cleaning step achieved an 8 fold reduction and disinfection achieved a 16 fold reduction in microbial loads.

The same investigation looked at some specific details of cleaning and found that:

- The optimal distance for a pressure spray nozzle from a surface is between 125mm and 250mm, but a variety of distance produces relatively little significant change in microbial reductions
- The number of organisms removed from a surface did not significantly change with different pressures of between 17.2 to 68.9 bar over 5 seconds,
- Out of three different detergents (acidic, neutral and alkaline), the acidic detergent showed a slightly better rate of removal compared to the neutral and alkaline detergents, in their ability to remove *Pseudomonas aeruginosa* and *Staphylococcus aureus* bacteria, however other studies found that different detergents are more effective at removing different microbes. The conclusion was that the choice of detergent should be made according to the specific microbes that are growing in a factory.
- The use of a mechanical scrubber or high pressure spray was more effective that a manual low pressure rinse protocol or a gel detergent treatment protocol. As scrubbers are not able to be used on all sites, manual brush scrubbing was effective and also a better mechanism for management of aerosols that are generated through use of high pressure sprays and mechanical floor scrubbers

It has been shown that bacterial biofilms cannot be removed through using one single detergent or one single disinfectant regime, A “rotational” regime is recommended where critical sites are identified and are they are given special “deep clean” attention in daily turns and, if necessary, special treatment. The special treatment should include a manual scrub step. Manual scrubbing has been shown to significantly reduce microbial loads (Table 2.5.5). Sites that are not identified as critical sites are called “observation” sites and are cleaned through a routine or “frequency” program.

A good sanitation process will include the following:

- Critical sites cleaned on rotational sanitation,
- Observation sites cleaned on frequency sanitation,
- Regular measures made of the bacteriological effect of the sanitation program, and
- Appropriate detergents, disinfectants and sanitation program selected (Jessen & Lammert, 2003)

The common means of monitoring the bacteriological effect of the sanitation program includes surface swabs however monitoring for the effects of inadequate cleaning and disinfection is only discernible during the first hour of production, thereafter they are obscured by contamination from the carcasses as they pass.

Appendix 1 is a guideline document that brings together cleaning methods and target guidelines and measures for specific equipment and facilities within the abattoir environment.

Table 2.5.5: Comparison of the effectiveness of a range of cleaning techniques in terms of removal of the factory generated biofilm

Cleaning treatment	*Bacteria Count / Biolfilm (cells)*
Control (untreated biofilms)	$1{\cdot}7 \times 10^8$
Normal factory clean (low pressure rinse, disinfection, rinse)	$1{\cdot}5 \times 10^8$
Gel detergent plus low pressure rinse	$1{\cdot}6 \times 10^8$
Mechanical floor scrubber	$6{\cdot}6 \times 10^5$
High pressure spray wash	$8{\cdot}9 \times 10^4$

Based on (Gibson, Taylor, Hall, & Holah, 1999)

2.5.2 Processing

The primary sources of microbial contamination in slaughtering are from the animal, in particular from the hide and from the gut of the slaughtered animals. The adoption of HACCP principles into abattoir operation has been mandated across Australia. However Jenson & Sumner note that Australian processors have chosen not to use antimicrobial interventions in processing as a CCP, but rather relied upon "processing clean cattle and employing a trained and stable workforce to de-hide, eviscerate and trim at a relatively slow rate".

As a means of preventing the opportunity for biofilm development a "dry floor" policy is recommended to better manage moisture and microbial growth opportunities. This means:

- Removing waste at the source and rinsing liquid waste straight to drain,
- No rubber boots or aprons, which require wet wash cleaning,
- Normal safety shoes,
- No-boot washers at production,
- Hoses and mops locked during production,
- Rubber blades with scoops and bins only, for the removal of waste that falls to the floor,
- Good ventilation, and
- Controlled wet cleaning where necessary, for example, use of impregnated wet wipes.

Air is a potential vector of bacterial contamination and effective separation of "dirty" and "clean" areas along with abattoir design significantly affects the extent and transfer of airborne contamination.

2.6 Identifying Water Saving Options

The process for conducting a water audit is relatively simple and can be applied in a variety of ways to achieve the desired outcome. The following is a procedure that has been proven successful.

1) Management Commitment
    - Ensure Top Management Support

Management support is needed to ensure that sufficient resources are made available for the audit to occur. In simple terms this means that staff have time available to participate and are given freedom and encouragement to express their ideas. Management will ensure that support such as record keeping and notes are made and that there is access to relevant information.

- Set the Goals to be Achieved
  Clear goals are needed to assist the participants stay focussed. A generalised goal should be broken down into simple goals so that the staff involved can work efficiently on one issue at a time.

- Get Employee Participation
  Employee participation is critical as they will bring a hands on perspective and provide valuable input into actual procedures that occur. They can also contribute to the measurement and gathering of data.

- Identify Key Roles (Conservation Manager)
  Creating a key role of Conservation Manager provides a focus point for information and activities revolving around the work of the team. Reports from the audit can be channelled back to management via the Conservation Manager. Activities of the water audit team can be overseen and driven by the Conservation Manager.

2) Establish a Factory Water Conservation Team
   The water conservation team will action the water audit. Including participants from different section of the factory will help to provide a broad pool of knowledge and experience.

3) Conduct a Water Audit
   - Scope
     In an abattoir the scope of the audit can include review of the following water uses
     - Steriliser water
     - Process water,
     - Cooling water,
     - Water for steam generation, and
     - Cleaning, wash down, floor and equipment wash water.

   - Water Process Flow Diagrams
     The team should prepare, review and assess water process flow diagrams for each type of water consumed. This study will illustrate how water of different quality is used across the plant.

   - Collect Data
     Once the water process flow diagrams have been evaluated there will be some basic assessment to determine which areas are most likely to yield water saving opportunity. More detailed

relevant data collection should then be collated. This can include the:

- Total annual monthly water consumption for the entire facility
- Monthly water consumption for each plant
- Raw material consumption and annual consumption rate for various products (e.g. per head)
- Number and capacity of boilers
- Number and capacity of cooling towers
- The presence of barometric leg condensers
- Factory sewer lines
- Segregation/integration of different types of water
- Washing/rinsing procedure
- Maintenance of pipes and fittings
- Wastewater quality
- Quality of consumed water (well water, softened water, de-ionised water, drinking water, reuse water)

4) Identify water saving opportunities

Assessment of the data will allow a cost benefit assessment to be completed and the development of an implementation plan. Payback time and cost saving are the primary criteria for deciding which strategies to employ.

5) Evaluate the expected water savings

The following steps can be used to calculate the potential savings that can be achieved through the steps implemented

- Water flow rate is measured using flow meters
- Measurements are taken at the same time over a period of 1 month and several times per day
- Maximum, minimum and daily average for water consumption is calculated
- The amount of water saved by implementing the measure is calculated and the cost of water saved
- Cost savings are estimated based on current production rates and on estimated maximum production
- The cost of the measure is estimated and the cost benefit calculated

The following case studies show the cost savings achieved by food manufacturers who implemented water audit and conservation procedures.

Case Study 3: Use of water at less than 82°C for sanitising abattoir knives

In the course of assessing the potential for low temperature operation of knife sterilisers, the volume of water needed to maintain 82°C knife steriliser compared to a 72°C knife steriliser was monitored. Weekly water consumption for the plant when operating knife sterilisers at 82°C was 320kL per week. Reduction of the temperature from 82°C to 72 °C is achieved through adjustment of ball valves for flow control. The reduction in temperature resulted in significant water savings and has the potential to reduce water consumption by more than 50% to below 160kL per week. Further water savings may be possible by adopting the practice of alternating two knives with immersion in 60˚C water between use.

Studies in Belgium showed water savings of up to 10% through application of simple low cost measures, and that further investment in state-of-the-art technologies would deliver savings of 30%.

It is estimated that a 10-50% saving in water consumption can be achieved simply by educating staff on how to reduce unnecessary consumption and increasing their awareness of water saving efforts. The 2003 MLA Industry Environmental Performance Review noted that in the preceding five years there had been an 11% reduction in raw water usage across the industry, partially attributable to water saving innovations and employee training. The 2010 MLA Industry Environmental Performance Review noted another 11% reduction across industry.

Additional actions can include water conservation activities that are being adopted across other industry sectors and environments such as waterless urinals in staff amenities and diversion of reuse water to vehicle washing or garden/farm irrigation.

Case Study 4: Payback on Water Conservation Projects in less than 6 months

Relatively low cost and straightforward interventions were used at a one of Egypt's largest preserved and frozen food production facilities that operates three 8 hour shifts per day and includes production of juice, tomato paste, canned beans and canned vegetables, frozen vegetables, agar-agar and tin can manufacturing. Due to scarcity of supply and rapidly increasing demand for water in Egypt, food manufacturers are keen to decrease production cost by reducing water consumption. The water audit process achieved the following water conservation outcomes and paid back investments in less than 6 months.

Project Description	***Payback Time***	***Cost (LE)***	***Cost Saving (LE/y)***
Rehabilitation of the cooling system for tomato paste production line	28 days	20,000	264,000
Upgrading hose nozzles	1 month	2,500	30,000
Washing and cooling of tomato paste cans	3.5 months	1,500	5,200
Rehabilitation of a water collection system	4.5 months	6,000	16,000
Cooling tower for juice bottle steriliser	5 months	75,000	200,000
Total		**105,000**	**515,200**

2.7 Benchmark against other businesses

Benchmarking is used to find the best-in-class practices so that they can be used as a reference point for comparison to your business operation. Best practice water reduction strategies and initiatives for the meat industry have been developed both in Australia and overseas. Some are listed in the following table 2.7.2

Benchmarking your water consumption against other similar businesses will help to identify how well your water conservation efforts are working. A good comparison needs the comparative businesses to be similar operation. In the cases of discrete businesses that are parts of a larger organisation this will be easier than for businesses that are stand alone or unique in their operation. There is readily accessible information in the public domain that can be used as a point of reference including the MLA Industry Sustainability Review 2010 and MLA data from the water consumption at a typical Australian meat plant (Table 2.7.1).

Table 2.7.1: Example Breakdown of Water use at a Typical Australian Meat Plant[1]

			kL/day	% of total	
Variable water use	Stockyards	Stock watering	10	1.0%	25%
		Stock washing	70	7.0%	
		Stockyard washing	130	13.0%	
		Truck washing	40	4.0%	
	Slaughter and Viscera	table wash sprays	60	6.0%	10%
		evisceration Head wash	3	0.3%	
		Carcase wash	40	4.0%	
		Carcase splitting saw	1	0.1%	
	Paunch, gut and offal washing	Paunch dump and rinse	80	8.0%	20%
		Tripe / bible washing	30	3.0%	
		Gut washing	60	6.0%	
		Edible offal washing	30	3.0%	
Fixed water use	Rendering	Rendering separators	10	1.0%	2%
		Rendering plant wash down	5	0.5%	
	Sterilisers and wash stations	Knife sterilisers	60	6.0%	10%
		Equipment sterilisers	20	2.0%	
		Hand wash stations	20	2.0%	
	Amenities	Exit / entry hand, boot and apron wash stations	40	4.0%	7%
		Personnel amenities	25	2.5%	
	Plant cleaning	Wash down during shifts	20	2.0%	22%
		Cleaning and sanitising at end of shift	170	17.0%	
		Washing tubs, cutting boards and trays	30	3.0%	
	Plant services	Condensers	20	2.0%	4%
		Cooling tower makeup	10	1.0%	
		Boiler feed makeup	10	1.0%	
		Refrigeration defrost	3	0.3%	
	Total		**1,000**		**100%**
	Per unit of production (kL/tHSCW) 7		**7**		
	Cold water		687	69%	
	Warm water [2]		85	9%	
	Hot water [3]		225	23%	
	Fixed water use		443	44%	
	Variable water use		554	55%	

Source: (MLA, 1995) Collation of data from MLA, 1995b and internal data of the UNEP Working Group for Cleaner Production

[1] A 'typical meat plant' is defined as a plant processing the equivalent of 150 tonnes Hot Standard Carcase Weight (HSCW) per day, which is equivalent to 625 head of cattle per day, based on a conversion rate of 240 kg/head. Production is assumed to take place 5-days per week, 250 days per year, and boning and rendering takes place.

[2] Warm water is used for hand wash stations exit/entry hand, boot and apron wash stations and personnel amenities.

[3] Hot water is used for knife and equipment sterilisers, and for viscera table wash sprays, tripe/bible washing, cleaning at the end of shifts and washing tubs etc.

A summary of Best Available Techniques (BAT) for pollution prevention and control has been developed by the EU and includes water efficiency measures that can be readily applied to any production facility. Many of the measures are simple and can be quickly and easily implemented. It includes all of the following "General" measures listed in Tables 2.7.3 to 2.7.5.

Table 2.7.2: Key Water Reduction Strategies and Initiatives

Strategies	Recent Australian Initiatives
• Undertaking dry cleaning of trucks prior to washing with water, • Using automatically operated scalding chambers rather than scalding tanks for de-hairing pigs, • Using offal transport systems that avoid or minimise the use of water, • Using dry dumping techniques for the processing of cattle paunches and pig stomachs that avoid or minimise the use of water, instead of wet dumping techniques, • Reusing relatively clean wastewaters from cooling systems, vacuum pumps, etc., for washing livestock • Reusing final rinse waters from paunch and casings washing for other non-critical cleaning steps in the casings department, • Reusing wastewaters from the slaughter floor, carcass washing, viscera tables and hand-washing basins for the washing of inedible products • Reusing cooling water from the singeing process for other application in the pig de-hairing area • Reusing the final rinse from cleaning operations for the initial rinse on the following day, • Using dry cleaning techniques to pre-clean process areas and floors before washing with water • Using high pressure rather than high volume for cleaning surfaces • Using automatic control systems to operate the flow of water in hand wash stations and knife sterilisers	• Reused water captured from sealing and cryovac machines throughout the plant, • Reused water used for yards wash down, cattle pre-wash, truck washing and other non-potable applications, • Installed sensors on hand wash stations and sterilisers, • Hose nozzle size reduction (high pressure, low volume), • Condenser side stream filtration, • Establishment of laundry on-site, • Recycling of viscera table water • Collect steriliser water, hand wash water and boot wash and reuse for wash down at rendering and wastewater treatment areas and other areas requiring non-potable wash down.

Table 2.7.3 General Water Efficiency Control Measures

General	Water Efficiency
• Use an environmental management system • Provide training • Use a planned maintenance programme • Implement energy management systems • Implement refrigeration management systems • Operate controls over refrigeration plant running times • Fit and operate chill room door closing switches • Recuperate heat from refrigeration plants • Use thermostatically controlled steam and water blending valves • Rationalise and insulate steam and water pipework • Implement light management systems, • Clean materials storage areas frequently, • Replace the use of fuel oil with natural gas, where a natural gas supply is available • Export any heat and/or power produced which cannot be used on-site.	• Apply dedicated metering of water consumption • Separate process and non-process waste water • Remove all running water hoses and repair dripping taps and toilets • Dry clean installations and transport by-products dry, followed by pressure cleaning, using hoses fitted with hand-operated triggers and where necessary hot water supplied from thermostatically controlled steam and water valves • Isolate steam and water services • Design and construct vehicles, equipment and premises to ensure that they are easy to clean

Table 2.7.4 Slaughterhouse Specific Water Efficiency Control Measures:

General	Water Efficiency
• Operate a double drain from the bleed hall • Insulate and cover knife sterilisers, combined with sterilising knives using low-pressure steam • Manage and monitor ventilation use • Use backward bowed centrifugal fans in ventilation and refrigeration systems • Trim all hide/skin material not destined for tanning immediately after removal from the animal, except if there is no outlet for the use/valorisation of the trimmings	• Dry scrape delivery vehicles and prior to cleaning with a high pressure hose • Avoid carcase washing and where this is not possible to minimise it, combined with clean slaughter techniques • Collect floor waste dry • Remove all unnecessary taps from the slaughter-line • Operate hand and apron cleaning cubicles, with a “water off” default • Manage and monitor the use of hot water

Table 2.7.5 Additional Slaughterhouse Specific Measures for the Slaughter of Large Animals:

General	Water Efficiency
• In those existing slaughterhouses, where it is not yet economically viable to change to steam scalding, insulate and cover pig scalding tanks and control the water level in those tanks • Recover heat from pig singeing exhaust gases, for preheating water • According to the current Reference Document on Best Available Techniques for the Tanning of Hides and Skins [273, EC, 2001] BAT "is to process fresh hides and skins as far as they are available". • When it is impossible to process hides and skins before 8 – 12 hours, with the actual range depending on local conditions, to immediately store hides between 10 and 15 ºC • When it is impossible to process hides before a period of between 8 – 12 hours and 5 – 8 days, with the actual ranges depending on local conditions, to immediately refrigerate hides at 2ºC • Always immediately drum-salt all hides and skins, if they have to be stored for longer than 8 days, e.g. if they have to be transported overseas, combined with the dry collection of salt residues	• Apply demand-controlled drinking water • Shower pigs using water saving timer controlled nozzles • Dry clean the lairage floor and to periodically clean it with water • Use a squeegee for the initial cleaning of the blood collection trough • Steam scald pigs (vertical scalding), • Re-use cold water within pig de-hairing machines and replace irrigation pipes with flat jet nozzles • Re-use cooling water from pig singeing kilns • Shower pigs after singeing, using flat jet nozzles • Replace irrigation pipes with flat jet nozzles for rind treatment in pig slaughterhouses • Sterilise chest-opening saws in a cabinet with automated hot water nozzles • Regulate and minimise the water used for moving intestines • Use either water-spray/mist-cooling or blast-chilling/shock-cooling tunnel to cool pigs • Do not shower pigs before they are chilled in a chilling tunnel • Regulate and minimise the water consumption during small and large intestine washing • Regulate and minimise the water consumption during rinsing of tongues and hearts

2.8 Water Reuse & Recycling

Water reuse and recycling is desirable from a sustainability perspective, however water quality, treatment costs and relevant environmental legislation must be considered before embarking on a water reuse and recycling program. In abattoirs there are potential applications for reuse and recycled water in areas such as cleaning of transport vehicles and cleaning of waiting/holding areas. Reuse or recycled water has the potential uses in replenishing scalding tank, re-use cold water within pig de-hairing machines and reuse cooling water from pig singeing kilns.

In Australia there are guidelines available for drafting management plans for water recycling. These need to be considered with respect to State regulations that can overlap the Federal guidelines.

In the CODEX Alimentarius Commission, ‘‘Proposed Draft Guidelines for the Hygienic Reuse of Processing Water in Food Plants’’ the guidelines specify the following:

- Reuse water shall be safe for its intended use and shall not jeopardise the safety of the product through the introduction of chemical, microbiological or physical contaminants in amounts that represent a health risk to the consumer;
- Reuse water should not adversely affect the quality (flavour, colour, texture) of the product;
- Reuse water intended for incorporation into a food product shall at least meet the microbiological and, as deemed necessary, chemical specification for potable water. In certain cases physical specifications may be appropriate;
- Reuse water shall be subjected to on-going monitoring and testing to ensure its safety and quality. The frequency of monitoring and testing are dictated by the source of the water or its prior condition and the intended reuse of the water; more critical applications normally require greater levels of reconditioning than less critical uses;
- The water treatment system(s) chosen should be such that it will provide the level of reconditioning appropriate for the intended water reuse;
- Proper maintenance of water reconditioning systems is critical;
- Treatment of water must be undertaken with knowledge of the types of contaminants the water may have acquired from its previous use; and
- Container cooling water should be sanitised (e.g. with chlorine) because there is always the possibility that leakage could contaminate the product.

3 Hygienic Design to Reduce Water Consumption

3.1.1 The Practical Benefits of Hygienic Design

Equipment that is poorly designed can have reduced cleanability, meaning that soiling is not easily freed. If equipment is designed well then it can be cleaned easier and better. There is a real and measureable cost benefit through applying hygienic design.

Case Study 5: Remediation of Poor Hygienic Design

An abattoir hygiene audit reveals three issues that consume disproportionate amounts of cleaner's labour time and are able to be better engineered to save cost:

1. A steam line has been installed close to the hide puller. During normal operations, splash from the hide puller falls onto the steam line. The external surface of the steam line is uninsulated and heats to approximately 98°C. Any blood splash falling onto the steam pipe is cooked and burnt onto the pipe. Each night, the cleaners allocate one person to spend one hour hand scrubbing the steam pipe to remove the burnt on material. Insulating the steam line could reduce the surface temperature of the pipe and allow faster cleaning; however there is insufficient space to install insulation around the pipe in the existing location. The decision is made to re-lay the steam pipe along a nearby wall and apply insulation at the same time to reduce heat loss. There is an immediate saving of one hour cleaning time per day.
2. A waste transfer pipe has been laid under the evisceration table conveyor, but a gap exists between the offal pipe and a small retaining wall that supports the evisceration table conveyor. Access into the gap is restricted as the conveyor runs close to the top of the wall. Offal falls off the table and into the gap. Cleaning is only managed by a cleaner lying under the table and crawling along the length of the table to reach in and clean offal from out of the gap. An inclined drip tray is installed under the evisceration table that catches spillages and stops them from falling into the gap. This installation saves two hours of cleaner's time per night.
3. Cabling to various saws has been protected using corrugated flexible conduit. The corrugations cannot be easily opened to remove accumulated filth. The abattoir embarks on a program to replace corrugated conduit with food grade spiral cabling that does not accumulate as much residue and is easy and faster to clean.

3.1.2 Applying Hygienic Design

Hygienic design can be used to assess existing equipment or it can be used as a tool for assessment of new equipment. As the principles of hygienic design have been mandated in the EU, there is now opportunity to access information on the hygienic design of equipment in advance of purchase.

Hygienic practices are concerned with:

- Processes that return the processing environment to its original condition (cleaning and sanitation programs),
- Practices that keep the building and equipment in efficient operation (maintenance programs),
- Practices that relate to the control of cross contamination during manufacture being control of people, surfaces, air, and segregation of raw and cooked product (personal hygiene and good manufacturing practices).

The text "Handbook of hygiene control in the food industry" (Lelieveld, Mostert, & Holah, 2005) is a detailed text encompassing improved design in the food industry. It includes extensive information on buildings, zoning, floors, walls, closed equipment, heating equipment, dry material handling equipment, packaging equipment, electrical equipment, valves, pipes, pumps, and sensors. A simple set of good hygienic design criteria are listed in the Table 3.1.1 below:

Table 3.1.1: Hygienic Design Criteria

Design Parameters	***Generally recommended criteria for the food area[a] in equipment***
Construction materials	Durable, cleanable, disinfectable; resistant to cracking, abrasion and corrosion; non-toxic, non-absorbent; do not transfer undesirable odours etc.; do not contribute to contamination of food. Suitable materials are e.g. stainless steels EN 1.4301 (AISI 304), EN 1.4404 (AISI 316L), EN 1.4435(AISI 316l), EN 1.4571 (AISI 316Ti) and plastics (see Conveyer belts)
Surface finish	Cleanable, disinfectable, smooth, continuous, prevents trapping of microbes, $R_a \geq$ 0.8µm
Drainability	Self-draining
Corners	Rounded, no dead spaces, cleanable, disinfectable
Joints	Sealed, hygienic, no gaps or crevices, protruding ledges and seals should be avoided
Welds	Smooth, continuous; no misalignments, cracking or porosity; sloped edges
Fasteners (screws, bolts)	Avoid if possible; cleanable, disinfectable
Seals/Gaskets	Tolerate processing conditions without changes, cleanable, disinfectable, suitable materials include e.g. EPDM[b], NBR[c], nitrile rubber, silicone rubber, Viton rubber
Rims	No ledges where product can lodge; cleanable, top rims rounded and sloped
Bearings, shafts	Located outside the food area, cleanable and disinfectable, food grade lubricant used
Panels, covers, doors	Prevent entry of soil and contaminants, cleanable, disinfectable
Instrumentation and control devices	Prevent ingress of contamination, sanitary couplings
Conveyer belts	Non-absorbent, covered edges, rounded rims, cleanable, disinfectable, tolerant; suitable materials PP[d], PVC[e], acetal copolymer, PC[f], HDPE[g]
Placing and installation	Electronic devices in the non-food area, sealed to floor, rounded pedestal, clear space everywhere around the equipment to enable cleaning

[a] Area composed of surfaces in contact with food; the food area also includes the surfaces with which the product may come into contact under intended conditions of use, after which it returns into the product (CEN, 1997).

[b] ethylene propylene diene monomer [c] nitrile butyl rubber [d] polypropylene
[e] polyvinyl chloride [f] polycarbonate [g] high density polyethylene

(Aarnisalo, 2008) (Hauser, et al., 2004)

3.1.3 Hygiene Risk Assessment

The Machinery Directive (EC, 2006) stipulates that manufacturers of machinery must conduct risk assessments to determine the health and safety requirements that apply to the machinery. The machinery must then be designed and constructed taking into account the results of the risk assessment.

In the process of hygiene risk assessment the manufacturer shall:

- Determine the limits of the machinery, including the intended use and any reasonably foreseeable misuse,
- Identify the hazards that can be generated by the machinery and the associated hazardous situations,
- Estimate the risks, taking into account the severity of the possible injury or damage to health and the probability of its occurrence,
- Evaluate the risks, with a view to determining whether risk reduction is required,

- Eliminate the hazards or reduce the risks associated with these hazards by application of protective measures, in order of priority.

When conducting a hygiene risk assessment, it is crucial to understand the properties and behaviour of microbes and so the team involved in the hygiene risk assessment should include engineers, designers and scientists with appropriate microbiology expertise.

3.2 Equipment Design

When automating a slaughter line, hygienic design needs to be incorporated into the development process as early as possible. If tools used in an automated slaughter line are effectively disinfected between each carcass this will improve hygiene, particularly with respect to cross contamination.

The persistence of *E. coli* in equipment that is regarded as well cleaned implies that beef may be contaminated from persisting and proliferating bacterial populations at obscured areas of carcass breaking equipment.

Holah (Holah, 2000) and Seward (Seward, 2007) listed up to 11 principles of hygienic design for all aspects of a food processing facility detailed in the Table 3.2.1:

Table 3.2.1 Comparison of the Principles of Hygienic Design by Holah and Seward

<table>
<tr><th>Holah</th><th>Seward</th></tr>
<tr><td>Factory siting and construction</td><td>Site elements facilitate sanitary conditions</td></tr>
<tr><td>Design of the building structure</td><td>Building envelope facilitates sanitary conditions</td></tr>
<tr><td>Selection of surface finishes</td><td></td></tr>
<tr><td>Segregation of work areas to control hazards</td><td>Distinct hygienic zones established in the factory</td></tr>
<tr><td>Flow of raw materials and product</td><td rowspan="2">Personnel and material flows designed to reduce hazards</td></tr>
<tr><td>Movement and control of people</td></tr>
<tr><td>Design and installation of the process equipment</td><td>Building components and construction facilitates sanitary conditions</td></tr>
<tr><td rowspan="2">Design and installation of services (air, water, steam, electrics, etc.)</td><td>Interior spatial design promotes sanitation</td></tr>
<tr><td>Utility systems designed to prevent contamination</td></tr>
<tr><td></td><td>Water accumulation controlled inside the facility</td></tr>
<tr><td></td><td>Room temperature and humidity controlled</td></tr>
<tr><td></td><td>Room air flow and room air quality controlled</td></tr>
<tr><td></td><td>Sanitation integrated into facility design</td></tr>
</table>

Hygienic design can be applied to specific parts within a production line, such as to seals and compressed air lines. Development in the hygienic design of seals and sealant materials has recently seen the development of metal detectable seals, antimicrobial seals and computer aided designed seals to minimise the potential for dead space between the seal and the housing. Guidelines for the design of elastomeric seals expect that there will be consideration of the specific environment in which the seal will function in combination with the seal material such that the mechanical properties (compression, hardness, year resistance, tensile strength, etc.) are most appropriate for the specific application.

The delivery of compressed air into equipment that is in food contact can import and disseminate microbes. Compressors should be oilless and fitted with filters (G4 or F5 standard) and condensation traps that will prevent microbes growing in the lines. This will then control the delivery of contaminants onto the meat via the equipment.

The design of the equipment needs to ensure that lubricated parts are protected from exposure to cleaning chemicals as there can be contamination of lubricants with food residues and/or microbes during the process of cleaning.

3.3 Aged or Worn Equipment

Aged or worn equipment will always be harder to maintain in hygienic condition, simply because food residues and microbes will accumulate in surface features such as scratches, roughness, finish lines, joints/welds and pores. Due to the interactions between the food, the surface and the environmental conditions (heat, acid/alkali) that can create enhanced binding, food material can be particularly difficult to remove.

Poorly maintained equipment can also wastefully consume more resources. Water leaks consume resources through the loss of the water for the purpose it was intended, the consumption of energy used to pump water to the point of intended use and the increased cost of treating greater volumes of wastewater. Table 3.3.1 shows calculated water loss due to different holes/leaks.

Table 3.3.1 Water loss from leaks at 4.5 bar pressure (UNEP, 1996)

Hole Size (mm)	*Water loss (m^3/day)*	*Water loss (m^3/year)*
0.5	0.4	140
1	1.2	430
2	3.7	1,300
4	18	6,400
6	47	17,000

3.4 Retro Fitting into Operating Facilities and Installations into Aged Facilities and Equipment

It is common that new equipment has to be fitted into an existing facility alongside existing equipment. These conditions create imperfect scenarios that impose hygienic design challenges. Such challenges can include:

- Modification of equipment to suit a specific location in the production line
- Modification by factory personnel who are not familiar with the standard required to achieve hygienic standard e.g. poor quality welds, installation of unhygienic structures such as overhangs
- Poor positioning of equipment such that there are obstructions or limitations to access for cleaning staff,
- Poor positioning of supply lines (e.g. steam or hot water supply lines) such that they are in close proximity to food or food waste resulting in burnt food waste accumulating on the supply lines that requires extra resources to clean,
- Use of inappropriate fittings that cannot be effectively cleaned, such as
    - Corrugated electrical cable coverings that accumulate meat residues and
    - non-slip floor gratings with small gaps that can accumulate meat but are too small to easily clean.

Case Study 6: Replacement of a Non-slip Gantry Floor

An abattoir runs a kill line for 19 hours a day, leaving the cleaning team a five hour window to quickly get in and clean the kill line and boning rooms. If the kill or boning rooms runs late, then pressure mounts as the cleaners gather and await the all clear to start, knowing that they have to be completed within their set time frame.

The Cleaning Manager identified one time consuming job that occupies one worker for two hours – cleaning entrapped offal out of a 3 metre length of fibre reinforced plastic gantry walkway.

In seeking an alternative the options included:

- Non slip checker plate
- Resin infused with Non slip aggregate
- Walkway mesh
- Fibre reinforced plastic

The Maintenance Manager is enthusiastic about Fibre reinforced plastic as it had been installed in several different locations across the facility. It is inexpensive, strong and does not corrode.

The Cleaning Manager is generally in agreement with the Maintenance Manager, except reports that the Fibre reinforced plastic is not suitable in the kill line or boning rooms as waste meat cannot be easily cleaned out of the cavities. Discarded meat and offal lodges in the cavities and is held entrapped by the non slip abrasive surface. It takes a patient and persistent cleaner two hours to hand clean a three metre walkway.

The team agree that non slip checker plate is the appropriate material for the walkway in the kill line and boning rooms. Fibre reinforced plastic is the preferred material in areas where there is less likelihood of waste meat and offal accumulation. This improvement is able to free up two hours of cleaner labour per night.

3.5 Design of a New Facility

Designing a new facility offers the opportunity to critically assess the water consumption needs of the production process and minimise waste. Kim and Smith (Jim, 2008) developed a five step procedure for assessing the water needs of equipment and processes to achieve efficiency of use. The steps in designing a water network include:

1. Calculate the minimum flow rate for each design region
2. Set up the design grid
3. Connect the water using operations with the water mains
4. Merge the water using operations
5. Remove the water mains and complete the water network

Further water minimisation is achieved through water reuse and recycling. Other practical design issues to be considered include the complexity of the process, restraints due to flow rate demands, water quality needs, engineering constraints, temperature constraints, economic costs and discontinuous operations (batch processes).

Case Study 7: Benchmarking Waste Streams to Worlds Best Practice

When a major Australian abattoir commissioned a new By-products processing facility, it provided rare opportunity to benchmark nutrient loads emitted into the waste stream, before and after the new By-products facility. The collection of relevant data included wastewater flow, contaminant concentrations and contaminant loads discharged. It also provided opportunity to analyse the waste streams from individual waste streams within the facility. The primary waste contributing waste streams were the:

- Kill floor red flows,
- Ante-mortem yard flows,
- Tripe processing flows,
- Cleaning flows from the kill floor and boning room and
- Boning room flow.

The waste streams that were of little significance were:

- Effluent from the boning room
- Miscellaneous by-products wash downs
- Paunch umbrella wash
- Truck wash and
- Human amenities

The installation of the new By-products plant and the measurement of waste streams allowed the business to identify areas where there were excessive uses of water to manage blockages. Installation of additional remediation equipment resulted in significantly better management of high strength raw material waste and has enabled the abattoir to meet world's best practice in terms of contaminant discharge in the raw wastewater.

3.6 Implementation

3.6.1 Training in Hygienic Design

Training in hygienic design will enable relevant personnel to better understand and apply the principles. Many researchers who are involved in hygienic design theory have emphasised that all persons who have direct or indirect contact with the food-producing area (e.g. inspectors, auditors, operators, fitters, QA personnel, engineers and designers) and those persons responsible for the management of sanitation programs need better training in hygienic design.

3.6.2 Testing and Assessing Hygienic Design

Procedures for testing and assessing hygienic design have been developed. These include a set of proprietary methods for testing and assessing hygienic characteristics of different equipment available through the EHEDG. The equipment can be submitted to an assessor for compliance against the EHEDG standard and a certificate of compliance issued. The specific equipment applications include methods for assessing:

- In-place cleanability of food processing equipment

- Bacteria tightness of food processing equipment and
- In-place cleanability of moderately-sized food processing equipment

Challenge tests can be a useful tool, where a microbial culture is inoculated onto a surface of object and then a cleaning procedure applied. The object is then swabbed and a measure made of the residual culture. This procedure needs to be performed under the expert guidance of a microbiologist and is best suited to applications outside of the food processing facility. The EU" Integrated Project Pathogen Combat" use a mixture of microbes and meat residues to create a "swimming pool" soup of contaminants that can be applied to or immersed around an object and then the cleanability measured.

3.7 Regulations & Standards

Regulations and Standards are written to provide information to either regulators or food manufacturers on the manner in which food is to be created from raw materials so that it will be safe for human consumption, either directly or after further processing. In the Australia New Zealand Food Standards Code (FSC) this is expressed in Standard 3.1.1 Section 2 describing the meaning of safe and suitable food (FSANZ). In particular the definition includes reference to "physical harm", and reference to "biological or chemical agent". Thus the FSC encompasses the three general hazards (physical, chemical and biological) that are described in Hazard Analysis and Critical Control Point (HACCP) theory. The hygienic design of equipment is crucial in contributing to a low base line microbial load of food. If the initial base line microbial load is allowed to increase, there is increased demand placed upon later food processing treatments to kill or control microbes. The current trend in consumer preferences for natural or less-processed food is putting emphasis back onto hygienic design to keep baseline microbial loads low and reduce the dependence upon bactericidal food preservation treatments.

The primary reference for equipment use in the Australian food industry is detailed in the FSC Standard 3.2.3 Food Premises and Equipment. These regulations are applicable across the entire Australian food industry. They are generalised and not specific to industry or to particular items of equipment. The Australian food manufacturing industry must ensure that they are in compliance with these regulations. As a generalised regulation, they are worded for the benefit of the inspector or auditor, rather than the manufacturer and there is little or no specific detail about equipment that can be used by the manufacturer. For example Standard 3.2.3 Division 4 states that "Fixtures, fittings and equipment must be adequate for the production of safe and suitable food and fit for their intended use". This statement encompasses all types of equipment across all manufacturing and retail sectors of the food industry.

The Australian Quarantine and Inspection Service (AQIS) is the Australian Federal Government agency with regulatory authority over meat establishments that export. The AQIS: Export Control (Meat and Meat Products) Orders 2005 and the guide "Construction and Equipment Guidelines for Export Meat" (AQIS) provide export establishments with specific and detailed information on the obligations that must be fulfilled. This document is specific to the meat industry and detailed in obligations placed up meat facilities including premises, equipment and cleaning procedures for different sections and rooms within meat processing facilities. This document does provide some specific details e.g.:

- The wash sequence for a moving head chain should be cold, hot (82˚C), cold and
- A dial face thermometer … should be fitted to the 82˚C wash water.

There is also information on Equipment design and construction, specifically in Section 42:

> 42.4.1 All parts of the product contact areas must be readily accessible to sight and reach or be capable of being dismantled to permit cleaning and inspection.
> 42.4.2 Interior corners in the product zone must be coved, having a minimum radius of 6 millimetres.
> 42.4.3 Welding within the product contact area should be continuous, smooth and flush with adjacent surfaces.
> 42.4.4 All parts of the product contact area should be free of recesses, open seams, gaps, crevices, protruding ledges, inside threads, bolts, rivets and dead ends.
> 42.4.5 Gasketing and packing materials should be non-toxic, non-porous, non-absorbent and unaffected by food products and cleaning compounds.
> 42.4.6 Seals and bearings should be located outside the product contact area.
> 42.4.7 Equipment requiring lubrication should be designed so that product is not contaminated by lubricant. Removable drip trays should be provided where necessary.
> 42.4.8 Where necessary, equipment should be self-draining or capable of being drained.

Establishments that are not exporting are required to comply with the Australian Standard AS4696:2007 Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption and AS4674-2004 Design, construction and fit out of food premises. Both of these documents reflect the detail of the FSC in that there are generalised, not detailed, instructions on equipment and premises hygiene and fitness for intended use.

There is a similar approach in international standards as illustrated in the EU Directive wherein it is noted: “Machinery intended for use with foodstuffs… must be designed and constructed in such a way as to avoid any risk of infection, sickness or contagion”. “The machinery must be designed and constructed in such a way that these materials can be cleaned before each use”

When a more detailed assessment of individual equipment is sought, a step-by-step logical approach to assessment of the hygienic design of any piece of equipment is outlined in ISO 14159. The process includes:

- Defining the limits of the machine, its intended use, the products and processes involved
- Applying an analysis of risks from
- Chemical,
- Microbiological and
- Physical hazards
- Applying a risk analysis on food safety aspects of these hazards.
- Choosing appropriate materials of construction
- Applying engineering guidelines in order to eliminate possible hazards
- Verifying the hygienic design of equipment
- Documenting the intended use of the equipment for installation, operation, maintenance and cleaning

A worked example of the calculation of risk analysis is described in detail by de Koning (de Koning, 2005) and is included in the Literature Survey associated with this report. The Risk Priority Number (RPN) is calculated by multiplying the

Frequency (F) x Exposure (E) x Severity (S) of the hazard. An arbitrary limit of 60 has been set in these cases, which will need to be validated in actual practice. In the EU, choosing not to apply this risk assessment process to equipment has been seen as acceptance of risk regardless of the "fact that a future occurrence of any one of these hazards could wreck their business and seriously injure or kill consumers".

Across Australia there are regional variations in regulations governing the meat industry. In 2009 the Productivity Commission summarised the regulations and regulatory bodies that govern the Australian and New Zealand meat industries (Table 3.7.1).

Table 3.7.1 Regulations and regulatory bodies by jurisdiction — meat

Region	***Documented requirements***	***Principal regulators*** [a]
NZ	*Food Act 1981* *Animal Products Act 1999* *Animal Products Regulations 2000* *Animal Products (Fees, Charges, and Levies) Regulations 2007*	New Zealand Food Safety Authority (NZFSA)
NSW	*Food Act 2003* *Food Regulations 2010* *NSW Standard for the Construction and Hygienic Operation of Retail Meat Premise*	NSW Food Authority (NSWFA)
Vic	*Food Act 1984* *Meat Industry Act 1993* *Meat Industry Regulations 2005* *Victorian Standard for Hygienic Production of eat at Retail Premises*	PrimeSafe
Qld	*Food Act 2006* *Food Production (Safety) Act 2000* *Food Production (Safety) Regulation 2002*	Safe Food Production Queensland (SFPQ)
SA	*Food Act 2001* *Primary Produce (Food Safety Schemes) Act 2004* *Primary Produce (Food Safety Schemes) (Meat Industry) Regulations 2006*	Meat Hygiene Unit of the Department of Primary Industries and Resources South Australia (PIRSA)
WA	*Food Act 2008* *Health Act 1911* *Health (Food Hygiene) Regulations 1993* *Health (ANZ Food Standards Code Adoption) Regulations 2001* *Health (Meat Hygiene) Regulations 2001* *Meat Industry Authority Act 1976*	Department of Health – Executive Director, Public Health (WA Health)
Tas	*Food Act 2003* *Meat Hygiene Act 1985* *Meat Hygiene Regulations 2003*	Chief Inspector of Meat Hygiene, Department of Primary Industries, Parks, Water and the Environment (Tas DPIPWE)
NT	*Food Act 2004* *Meat Industries Act 2007* *Meat Industries Regulations 2002*	Department of Regional Development, Primary Industry, Fisheries and Resources – Chief Inspector of livestock (NT DRDPIFR)
ACT	*Food Act 2001* *Food Regulations 2002*	Chief Health Officer – ACT Health

[a] The core food agencies in the Northern Territory and the ACT absorb food safety functions that would be undertaken by local councils in the Australian states. For all other jurisdictions, the core body responsible for regulation under the jurisdiction's Food Act generally devolves some monitoring responsibilities (for those businesses which provide food directly to the public) to local governments. The extent of devolution,

and subsequent coordination between local councils, varies between jurisdictions. In Victoria, if a business is both a primary producer and retailer, then the predominant activity undertaken by the business determines whether they are registered and inspected by PrimeSafe (predominately primary production) or by the local council (predominately retailers).

Jenson and Sumner (Jenson & Sumner, 2012) have recently reviewed the evolution of meat regulation in Australia and across our trading partners, including a review of performance standards and the Australian Export Meat Inspection System (AEMIS). The AEMIS is based on the reporting of set Key Performance Indicators (KPIs) used to produce a Product Hygiene Index (PHI). The KPIs include:

- Compliance with pre-operational sanitation microbiological performance standards,
- Compliance by operators with work instructions for hygienic dressing and processing,
- Complying with predicted *E. coli* growth on carcases during the chilling process,
- Assessing microbiological quality of chilled carcases (TVC, *E. coli* and coliforms),
- Assessing microbiological quality of processed primal (TVC, *E. coli* and coliforms), and
- Assessing freedom from visual defects (hair, dust, ingesta, pathology, bruising, etc.) in processed product.

3.8 Food Safety Targets

For export meat establishments Product Hygiene Indicators (PHI) and *E. coli* and Salmonella Monitoring (ESAM) programs are used to measure food safety targets and are verified by AQIS. Through these monitoring programs the microbiological criteria of beef carcases, cartooned beef and cartooned sheep meat have improved.

Outside of these export programs, individual States and territories apply regulations to either adopt these standards or apply local modifications that can include monitoring of plant and equipment hygiene e.g.: the NSW Food Authority General Circular 7/2003 requires processors to monitor work surfaces on a fortnightly basis:

- Surfaces to be free from protein materials
- Surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less,

This microbiological guideline is replicated from a CSIRO booklet (Sentance & Husband, 1993), which provides a detailed outline of the technical aspects of performing microbiological assessments of hygiene in the laboratory.

The Standards Australia Handbook for Microbiological Testing in Food Premises cross references to the APHA compendium for the Microbiological Examination of Foods 3rd Edition which that states “Adequately cleaned and sanitised food contact surfaces should not have more than 100 cfu per utensil or per area of equipment swabbed ($10cm^2$)”.

4 Conclusion & Recommendations

Many aspects of this report will be familiar to some producers who are early and enthusiastic adopters of best business practices. However there will be businesses who struggle to invest resources into these strategies. This project has assembled significant resources and tools that can be well used by the meat industry to convert sustainable actions into real value. The benefits will be best realised if these tools and resources are presented to industry in a format where they can discuss and challenge the concepts and ideas.

Applying water saving strategies will reduce current costs and enable businesses to forge their systems in readiness for water restriction situations, which in the Australian environment, occur frequently.

The adoption of hygienic design principles will provide benefits both in the short term and the long term. Immediate short term benefits include the reduction of cleaning costs as the time and effort spend in addressing poorly designed or sited equipment is reduced. The medium and long term benefits include the reduced likelihood of product contamination and the associated costs in managing contaminated product and loss of business.

Recommendation 1: Water Management & Hygienic Design Seminars
It is recommended that industry is informed of this report via industry seminars. These seminars will enable the dissemination of information contained within this paper to industry. A half day seminar will allow sufficient time to include worked examples of tools such as:

- Water audit,
- Factory map illustrating value of water saving actions converted into current dollar value
- Cleaning Plan review
- Hygiene Monitoring Program
- Appling Hygienic Design

The seminar can be presented either at central locations open to all industry, or at individual industry facilities, where there is opportunity to discuss the findings in specific context to that site. It can also be recorded and made available via DVD or other electronic format.

Recommendation 2: Distribution of Information
It is recommended that this report be distributed at the aforementioned seminars and available on-line to industry to assist all industry members to access up-to-date information on water management and hygienic design.

Recommendation 3: Training in Hygienic Design
Training of meat industry staff is necessary for effective application of hygienic design principles. Training in hygienic design through meat sector specific seminars by incorporating the concepts and applications of hygienic design specifically relevant to the meat industry would be useful.

It is recommended that a program of training in hygienic design for Australian meat industry personnel be developed and implemented.

Appendix 1: Hygienic Audit Guideline Checklist

RW = Reuse water option cfu/cm^2 = colony forming units per square centimetre

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.1	Knocking Box / Stun Pen	✓	✓ RW	✓		✓		✓	✓	Visual assessment: No visible dirt	Ensure that all debris is removed. Reuse water can be used for pre-rinse

Sources: www.gmsteel.com

www.industriesriopel.com

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.2	**Stunner**		✓ RW	✓		✓		✓	✓	Visual assessment: No visible dirt	Particular care around trigger and hand contact areas where dirt can accumulate in the hand grips non-slip ridges. Check that connecting support cables, connections and air lines are cleaned.

Sources: www.kentmaster.com

www.deprisafoodequipment.com

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.3	**Cradle**	✓	✓ RW	✓		✓		✓	✓	Visual assessment: No visible dirt	Particular care in inaccessible areas between the cradle and the floor where dirt can accumulate in difficult to access areas. Use of high pressure hoses may cause dirt to be pushed further into inaccessible areas, and so careful visual checking of inaccessible areas is important, use a torch if lighting is poor.
1.4	**Skids**		✓ RW	✓		✓		✓	✓	Visual assessment: No visible rust, grease or dirt build up.	Ensure that all debris is removed.

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.5	**Stiffener**		✓ RW	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed with particular care in cleaning touch points including: • Rails, • Cabinet ledges, and • Support strut hang-up points.
1.6	**Shackles**		✓ RW	✓		✓		✓	✓	Visual assessment: No visible rust, grease build up, dirt.	

Source: www.deprisafoodequipment.com

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.7	**Oesophagus Clip**		✓ RW	✓	✓	✓		✓	✓	Visual assessment: No visible rust, grease build up, dirt.	
											Source: www.kentmaster.com
1.8	**Bleed Rollers / conveyor**	✓	✓ RW	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt	Particular care in inaccessible areas between the rollers and the floor where filth can accumulate in difficult to access areas. Use of high pressure hoses may cause filth to be pushed further into inaccessible areas, and so careful visual checking of inaccessible areas is important, use a torch if lighting is poor.
1.9	**Bung elastrator**		✓ RW	✓	✓	✓		✓	✓	Visual assessment: No visible dirt	Particular care in inaccessible areas between the jaws and hand contact areas where dirt can accumulate in the hand grips non-slip ridges.
1.10	**Bung elastrator steriliser**		✓ RW	✓	✓	✓		✓	✓	Visual assessment: No visible dirt	

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.11	**Horn Cutter / Shear**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the blades, with particular care in inaccessible areas between the blades and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces between the jaws or around the blades, • Hand grips, • Air supply cables and • Support cables and connections.

Source: www.kentmaster.com

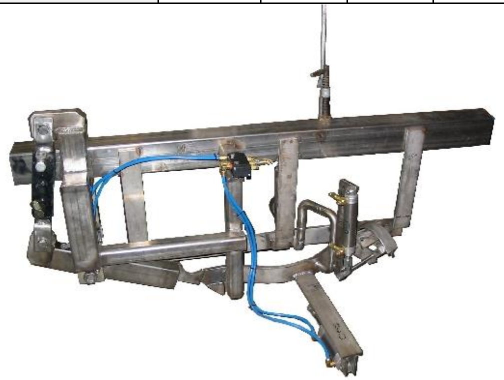


Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.12	**Hock Cutter**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the blades, with particular care in inaccessible areas between the blades and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces between the jaws or around the blades, • Hand grips, • Air supply cables and • Support cables and connections.
 Source: www.kentmaster.com											
1.13	**Hock cutter steriliser**		✓ RW	✓	✓	✓		✓	✓	Visual assessment: No visible dirt	Check carefully for any fragments of bone, meat or other debris and ensure they are removed before cleaning

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.14	**Stimulator conveyor**	✓	✓ RW	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt	
1.15	**Hide Cleaner**		✓ RW	✓	✓	✓		✓	✓	Visual assessment: No visible dirt	Check carefully for any hair or other debris and ensure they are removed before cleaning
											Source: www.kentmaster.com
1.16	**Change over hoist / winch**		✓ RW	✓	✓	✓		✓	✓	Visual assessment: No visible dirt	

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.17	**Leg conveyor**	✓	✓ RW	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt	

Source: www.industriesriopel.com



Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.18	**Brisket saw**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the blades, with particular care in inaccessible areas between the blades and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces between the jaws or around the blades, • Hand grips, • Air supply cables and • Support cables and connections.

Sources: www.kentmaster.com

www.deprisafoodequipment.com

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.19	**Brisket saw steriliser**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt	

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.20	**Air Dehider knife**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the blades, with particular care in inaccessible areas between the blades and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces around the blades, • Hand grips, • Trigger, • Air supply cables and • Support cables and connections.

Source: www.kentmaster.com

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.21	**Head Dropper**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the jaws, with particular care in inaccessible areas between the jaws and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces between the jaws, • Hand grips, • Trigger, • Air supply cables and • Support cables and connections.

Source: www.kentmaster.com

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.22	**Head Inspection Conveyor**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt	

Source: www.industriesriopel.com

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.23	**Tongue Bone Cutter**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the jaws, with particular care in inaccessible areas between the jaws and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces between the jaws, • Hand grips, • Trigger, • Air supply cables and • Support cables and connections.

Source: www.kentmaster.com

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.24	**Head Table & Chisel**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the vice, with particular care in inaccessible areas around hinges, cables and the support frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces around the chisel and jaws, • Air supply cables and • Support cables and connections.

Source: www.kentmaster.com

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.25	**Carcass Vacuum Cleaning**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the nozzle, with particular care in inaccessible areas around the nozzle and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces between the housing and the steam line connection, • Hand grips, • Air supply cables and • Support cables and connections.

Source: www.kentmaster.com

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.26	**Hock Vacuum Cleaner**	✓	✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings, with particular care in inaccessible areas around the attached nozzles and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces between the housing and the steam line connection, • Hand grips, and • Support cables and connections.

Source: www.kentmaster.com

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	

1.27	Hide Puller	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt,
										
										Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less
											Ensure that all debris is removed from frame, chains and platform, with particular care in inaccessible areas around the frame and platform where debris can accumulate in difficult to access niches. Particular attention to be made to:
											
											• Surfaces that are, or may be, in contact with the carcass
											• Hand touch points, including
											  • Railings,
											  • Faucets and
											  • Control switches.

Source: www.gmsteel.com

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	

1.28	**Rise & Fall Platform**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed from frame and platform, with particular care in inaccessible areas around the frame and platform where debris can accumulate in difficult to access niches. Particular attention to be made to:
											• Cables and connections.
											• Hand touch points, including
											  • Railings,
											  • Faucets and
											  • Control switches.

Source: www.gmsteel.com

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.29	**Splitter saw**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the blades, with particular care in inaccessible areas between the blades and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Surfaces around the blades, • Hand grips, • Air supply cables and • Support cables and connections.
 											Source: www.kentmaster.com
1.30	**Carcass Weight System**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt,	
1.31	**Conveyor**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt	Particular care in inaccessible areas between the rollers and the floor where filth can accumulate in difficult to access areas. Use of high pressure hoses may cause filth to be pushed further into inaccessible areas, and so careful visual checking of inaccessible areas is important, use a torch if lighting is poor.

Apparatus		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.32	**Head Wash**	✓	✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed from housings, with particular care in inaccessible areas between panels and the frames where debris can accumulate in difficult to access niches. Use of high pressure hoses may cause filth to be pushed further into inaccessible areas, and so careful visual checking of inaccessible areas is important, use a torch if lighting is poor. Particular attention to be made to: • Under bench framework and • Support cables and connections.
1.33	**Offal Screen**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed from screens, with particular care in inaccessible areas between screens and the frame where debris can accumulate in difficult to access niches. Use of high pressure hoses may cause filth to be pushed further into inaccessible areas, and so careful visual checking of inaccessible areas is important, use a torch if lighting is poor. Particular attention to be made to: • Behind spiral impellers and • Support cables and connections.

Source: www.mbasuppliers.com

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.34	**Evisceration (Gut) Table**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed from housings surrounding the conveyor, with particular care in inaccessible areas between the panels and the frames where debris can accumulate in difficult to access niches. Use of high pressure hoses may cause filth to be pushed further into inaccessible areas, and so careful visual checking of inaccessible areas is important, use a torch if lighting is poor. Particular attention to be made to: • Edges of the panels, • Under bench framework and • Support cables and connections.

Sources: www.gmsteel.com

www.fea.net.au

www.industriesriopel.com

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.35	**Gut Pans**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed from the pans, with particular care in inaccessible areas below the pans and the frames where debris can accumulate in difficult to access niches. Particular attention to be made to: • Support frames.

1.36	**Trim Platform**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed from frame and platform, with particular care in inaccessible areas around the frame and platform where debris can accumulate in difficult to access niches. Particular attention to be made to:
											
											• Cables and connections.
											• Hand touch points, including
											  • Railings,
											  • Faucets and
											  • Control switches

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.37	**Hand Wash**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed from drains, with particular care in cleaning touch points including: • Sink ledges, and • Faucets / switches.

Source: www.fea.net.au

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.38	**Apron Wash**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed from drains, with particular care in cleaning touch points including: • Sink ledges, and • Faucets / switches.

Source: www.gmsteel.com

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.39	**Knife Steriliser**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed from drains, with particular care in cleaning touch points including: • Sink ledges, and • Faucets / switches.

Source: www.industriesriopel.com

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.40	**Tables**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed with particular care in cleaning touch points including: • Table ledges, and • Support strut hang-up points.
1.41	**Vacuum fat remover**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the nozzle, with particular care in inaccessible areas around the hand grip where debris can accumulate in difficult to access niches. Particular attention to be made to: • Hand grips, • Vacuum supply cables and • Support cables and connections.

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.42	**Carcass wash tunnel**	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed with particular care in cleaning touch points including: • Cabinet ledges, and • Support strut hang-up points.
1.43	**Spinal cord extraction system**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that equipment is dismantled and all debris is removed from housings surrounding the nozzle, with particular care in inaccessible areas around the hand grip where debris can accumulate in difficult to access niches. Particular attention to be made to: • Hand grips, • Vacuum supply cables and • Support cables and connections.
											Source: www.mbasuppliers.com
1.44	**Hoses**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,	Ensure that all soiling is removed with particular care in cleaning touch points including: • Nozzles, and • Hose storage hooks / frames.

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.45	**Floor Scrapers**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,	Ensure that all soiling is removed with particular care in cleaning touch points. Particular attention to be made to: • Soil build up on the hand grip, • Soil build up around the blade • Soil accumulation between the folds of twin blade scrapers
1.46	**Knives**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed and the knife is in good hygienic condition. Particular attention to be made to: • Soil build up on the hand grip,
1.47	**Steels**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed and the steel is in good hygienic condition. Particular attention to be made to: • Soil build up on the hand grip,
1.48	**Pouch**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed and the pouch is in good hygienic condition. Particular attention to be made to: • Soil accumulation in the base of the pouch • Touch points on the belt,
1.49	**Chains**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed.
1.50	**Chutes**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed from chute, with particular care in inaccessible areas around the entry doors / panels where debris can accumulate in difficult to access niches.

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.51	**Shovels**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed and the shovel is in good hygienic condition. Particular attention to be made to: • Soil accumulation on the hand grip,
1.52	**Mesh gloves**		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed and the glove is in good hygienic condition. Particular attention to be made to: • Soil build up on the closure tab.

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references
1.53	Trolleys		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Ensure that all debris is removed and the trolley is in good hygienic condition. Particular attention to be made to: • Soil build up on the hand touch surfaces • Soil accumulation around the wheels and axles

Source: www.deprisafoodequipment.com

1.54	Tubs		✓	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,
										
										Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less
											Ensure that all debris is removed and the tub is in good hygienic condition. Particular attention to be made to:
											• Soil build up on the
											  • Hand touch surfaces
											  • Tub ledges

Apparatus		Recommended cleaning method								Target	Comments and references
		Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Guidelines & Measures	
1.55	**Pallet jacks**		✓ RW	✓	✓	✓		✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed and the pallet jack is in good hygienic condition. Particular attention to be made to: • Soil build up on the hand touch surfaces • Soil accumulation around the wheels and axles
1.56	**Electrical Control Panels, Keyboards & Switches**				✓			✓	✓	Visual assessment: No visible dirt, Microbiological swabs: surfaces to have a total bacterial count of 6 colony forming units (cfu) per cm^2 or less	Wipe clean with a damp cloth using sanitiser. Particular attention to be made to: • Soil build up on the switch surface, • Mould growth under cover plates

Apparatus		Recommended cleaning method: Scrape out and remove solid waste	Pre-rinse	Foam Detergent	Hand Scrub	Rinse	Squeegee dry	Sanitise	Dry	Target: Guidelines & Measures	Comments and references

1.57	Boot wash	✓	✓	✓	✓	✓	✓	✓	✓	Visual assessment: No visible dirt,	Ensure that all debris is removed from frame and platform, with particular care in inaccessible areas around the frame and platform where debris can accumulate in difficult to access niches. Particular attention to be made to:
											• Cables and connections.
											• Hand touch points, including
											  • Railings,
											  • Faucets and
											  • Control switches.

Sources: www.deprisafoodequipment.com

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