AMT
AUSTRALIAN MEAT TECHNOLOGY

Water and Waste Minimisation

Optimisation of Water Use and Control of Waste in Abattoirs

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Illustrated by
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This Manual is designed to assist with the overall reduction of water usage in the Australian Meat Processing Industry.

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This Manual is dedicated
to the memory of the late

Mr David Macfarlane

who undertook the initial planning for the Manual
and whose ideas form the basis of much of the material herein.

David's interest in meatworks engineering generally,
and in the management of water and waste water in particular,
have had considerable impact on the current level of
industry awareness of environmental issues.

His experience and knowledge in this important area,
which he freely shared with friends and colleagues,
will continue to benefit the meat industry
through this publication.

Acknowledgement

This manual contains the collective input of a number of meat industry engineers and others who have had considerable experience in the management of on-plant water and wastewater treatment facilities.

The working group comprising these people assisted in the development of the scope and content of the manual and provided many of the ideas and solutions to problems contained herein.

The contribution of the members of the working group is gratefully acknowledged.

Contents

Scope of this Manual

'Water and Waste Minimisation' is designed to assist in the efforts to reduce water usage on Australian meat processing plants.

The manual is divided into sections dealing separately with each department of a meat processing plant that uses significant quantities of water. Each section discusses aspects of water usage in a particular department and includes suggestions and recommendations on how water utilisation can be minimised and waste discharge reduced, through application of specific equipment and/or adoption of specific practices.

The processes and practices that use water in each department are discussed and in some cases the effects of over usage are also considered. Summaries are included that highlight specific points of interest. As well, there are tables that link common wastage mechanisms with indicators of wastage and associated solutions.

Water utilisation and wastewater treatment considerations overlap, so throughout the Manual, reference is made to waste reduction and the wastewater treatment system, in the context of water utilisation reduction and recycling. This integrated approach is consistent with the objective of the Manual, namely to reduce overall costs associated with water usage.

An appendix to the manual includes a Suppliers Index which is referred to in relevant sections of the text, where reference is made to specific pieces of equipment.

Introduction

This document is intended as a guide for abattoir managers and operators, to help develop effective water utilisation procedures and practices, in order to meet increasing demands for responsible environmental management.

The manual identifies abattoir operations that utilise water, and focuses on those areas that have the potential to impact on the environment through effluent discharge. By quantifying water usage in the areas identified and adopting suggested control strategies, plant management will be better placed to effectively control water usage.

Water consumed on plant is for the most part of potable quality when drawn from the local authority mains or from streams or bores. It costs between 10 and 60 cents a kilolitre to obtain. Chlorination, pumping and heating increase the cost to as high as $2.50 a kilolitre. Surveys carried out some years ago (*Graham 1978*) suggest that the amount of water consumed on meat plants ranged from 4.1 to 43.0 cubic meters per tonne of hot carcase weight (HCW) produced. Quantity of water used was usually inversely proportional to cost, i.e. consumption decreased as the cost increased. Typical consumption is currently of the order of 10 cubic meters per tonne HCW.

It is no longer appropriate to allow water usage practices to be governed mainly by the cost of the water supply. Changes in environmental regulations are shifting the emphasis from water supply to water disposal by introducing standards that are resulting in increased capital and operating costs for wastewater treatment systems.

Efforts to reduce overall water usage and to include recycling and re-use of treated wastewater where possible, are being encouraged by savings resulting from reduced supply costs, as well as by the requirements of the regulations themselves.

1

Water Sources

Potable water may be obtained singularly or in combination from a number of sources including:

- Local authority supply;
- Rain;
- Bores and wells;
- Rivers and Streams.

The maintenance of the potable water supply and it's quality requires attention be paid to a number of factors.

> Management of the water supply includes:
>
> - Meeting regulatory requirements to maintain specified quality;
> - Metering system to record usage.
>
> Measure consumption relative to production in order to monitor usage efficiency.

The factors that must be considered for the effective management of a plant water supply are as follows.

1. Regulatory Requirements

The water must meet the quality standards as laid down by AQIS in the Meat Export Orders (EMO's). It must be free from turbidity, colour, objectionable taste or odour and it must comply with specified microbiological criteria.

Potable water to be used in edible production must be effectively chlorinated. Effective chlorination requires a minimum residual concentration of 0.25 ppm after a contact time of at least 20 minutes.

As well as maintaining the required minimum residual chlorine concentration, the potable water shall be free of

E.coli, and contain no more than two coliforms per 100 ml.

On-plant chlorination systems should be fitted with alarm systems to ensure that if they malfunction, the problem can be attended to quickly before the residual chlorine concentration drops below the required level, or any undesirable microorganisms get into the plant's reticulation system.

2. Metering Water Usage

Irrespective of the source it is essential that water consumption is monitored to simplify management of this valuable resource. The best way to monitor water consumption is with water flow meters (refer Appendix pages 96 to 104).

- Local authority supply restrictions may well apply in rural areas especially during periods of extended drought. The supply is usually metered at the property boundary, normally by turbine meters with mechanical registers that totalise the cumulative flow through the meter. Meters must be read periodically in order to determine flow for a particular time. Newer meters offer the option of a pulse output, the number of pulses being relative to the flow rate, this enables automatic data collection via a computer or datalogger.
- Private bores are usually subject to approval by the local council and the licence stipulates the maximum volume of water that may be pumped annually.
  Bore capacity is established by testing during the initial commissioning and is expressed in cubic meters per hour. The water table or aquifer level affects pump capacity and it should be verified periodically.

A water meter installed in the pump discharge line is the most effective method of checking pump performance. It can also be measured by monitoring the pump running hours and relating the pump kW and delivery pressure to the performance curves for that specific pump model. Where the bore pump discharges into a storage tank, the capacity is readily measured by the time taken to deliver a known quantity into the tank. This is best done outside normal production hours when there is no draw-off from the tank.

3. Consumption Relative to Production

To be an effective management tool, daily water consumption readings should be collated and related to the daily production levels, either on a hot carcase weight (HCW) or equivalent cattle weight (ECW) basis. If daily hot carcase weights are readily available, this is the preferred method, being expressed as either litres per kg, or cubic meters per tonne HCW. The ECW method requires that various species of small stock, including pigs and goats, be allocated a value equivalent to beef. This method does not allow for the substantial weight variation within species.

Non-work day usage equals mostly avoidable losses. To identify problems caused by leaking services, valves left inadvertently open, or running taps, readings for weekend or other non-workday consumption should also be monitored. Unexplained consumption during these periods should be investigated as it is the ideal opportunity to identify on going problems that cannot be resolved during normal production hours.

2

Stockyards and Paddocks

Most meatworks, certainly most regionally located meatworks, hold livestock for varying periods prior to slaughter. Livestock for the following days kill are held in stockyards adjacent to the plant, however other livestock are generally held in paddocks around the plant where they are grazed and watered for sometimes several days prior to slaughter.

Water is used in stockyards and paddocks in a variety of ways including:

- Drinking;
- Stock washing;
- Washdown.

Each of these applications needs to be properly managed in order to avoid overusage.

> Management of water facilities in Stockyards and Paddocks includes management of both equipment and livestock:
>
> - Water trough maintenance;
> - Recycle control to maintain water quality;
> - Water use practices to minimise wastage;
> - Supplementary washing of dirty stock;
> - Hose damage prevention;
> - Pre-slaughter stress must be minimised;
> - Removal of solids from wash water.

There are a number of factors that need to be considered for the effective management of water supplies in stockyards and paddocks. These factors include both the management and maintenance of the equipment and facilities, and concern for the well being of the livestock.

1. Livestock Water Troughs

Overflowing drinking troughs are a relatively common problem in abattoirs. Besides being a waste of water they can quickly turn a paddock into a quagmire that will soil cattle and result in the need for extra washing to remove the accumulated mud before slaughter. Where possible troughs should be located to minimise ponding of the water in proximity to the troughs. The troughs should also be installed on a reinforced concrete base which extends at least 300 mm all around, and anchored to ensure that the cattle do not dislodge them.

Design of drinking troughs should provide protection for the ballcock and supply pipe against damage from cattle horns. The mechanism should be located behind a vertical baffle plate and the lid or cover bolted down. Readily accessible isolating valves should be provided for individual or groups of stock drinking troughs.

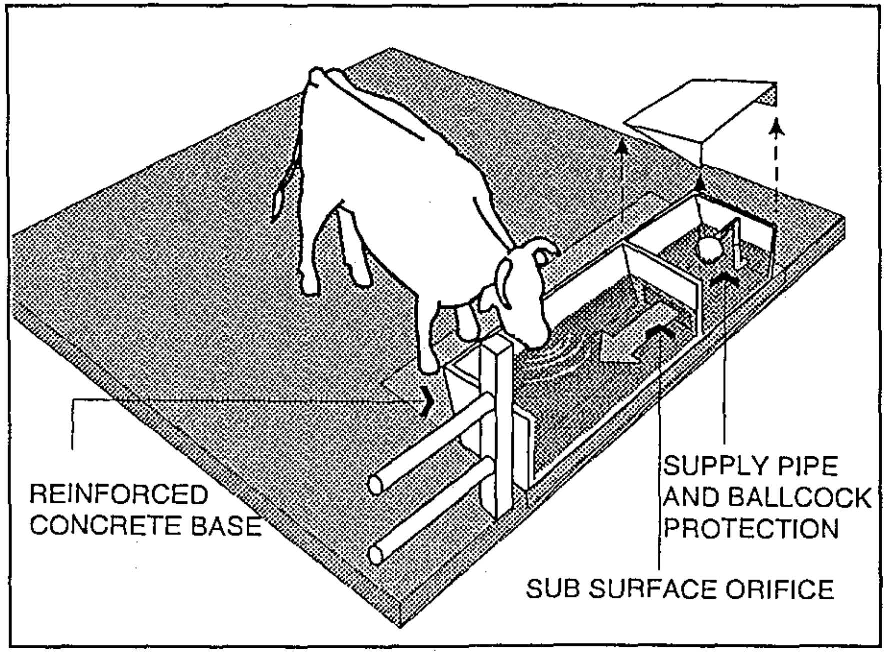

Figure 2.1 Drinking trough supply pipe and ballcock should be protected from damage by livestock.

Further protection can be provided by incorporating the drinking toughs in to the fence line between yards. Locate

rectangular troughs along the fence. Two semicircular or triangular troughs can be installed, back to back, at the junction of intersecting fences, to provide simultaneous access for cattle from up to four yards. A single water supply located between them can feed both troughs.

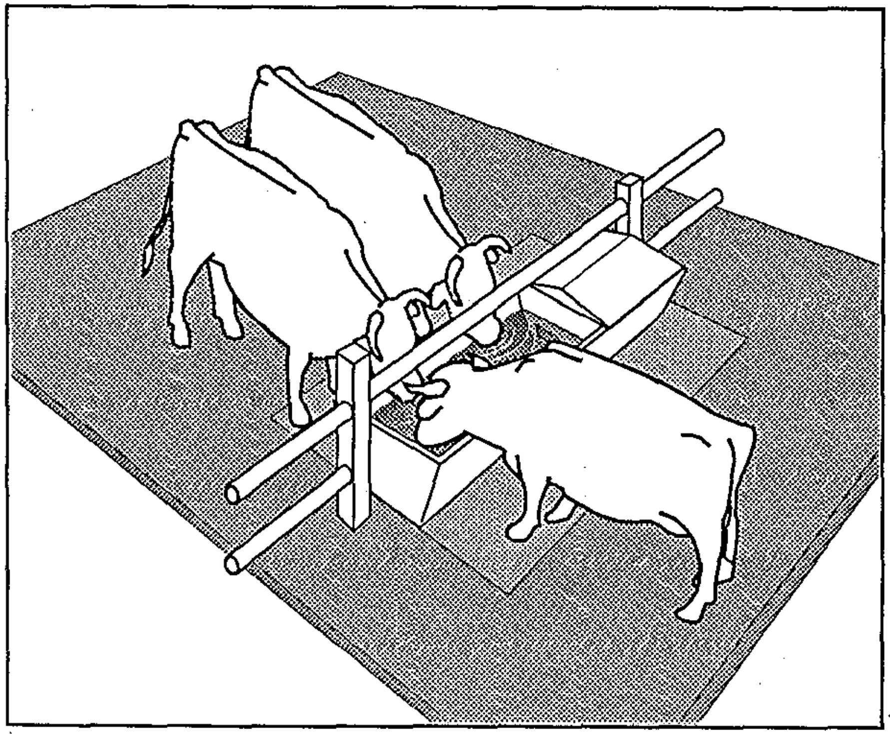

Figure 2.2 Rectangular drinking trough along fence line services two holding yards.

2. Recycled Water Usage

Except for European Union (EU) registered plants, recycled water may be utilised for livestock washing or stockyard washdown provided the final livestock rinse uses potable water.

An effective method of removing and recovering solids is required where recycled water is utilised in livestock washing. It is imperative that the recycled water does not increase the level of soilage or contamination. AQIS regulations also require an adequate supply of fresh make-up water and this can be provided by the drain-off from the final rinse section of the livestock wash.

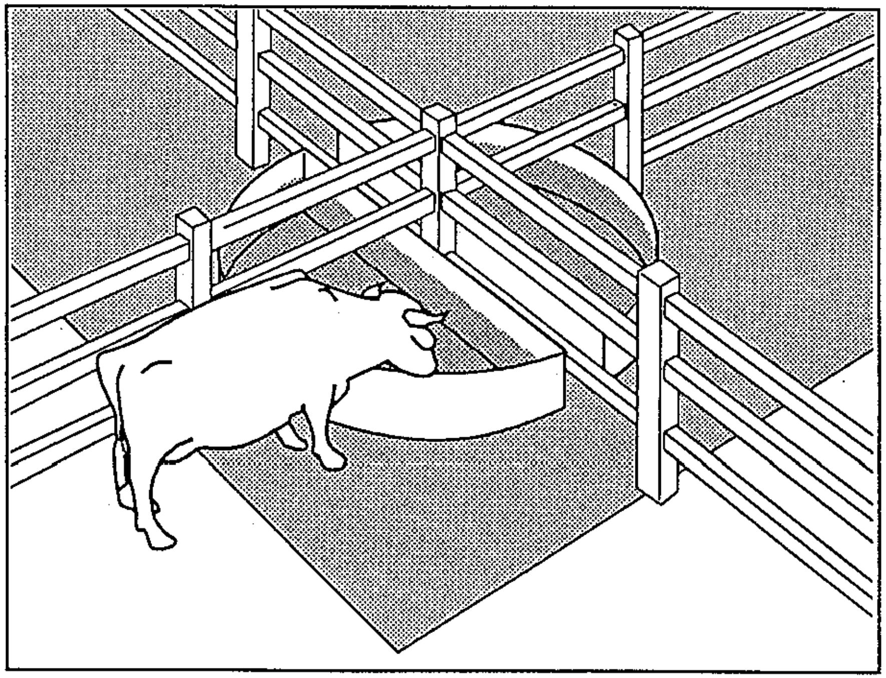

Figure 2.3 Two semicircular drinking troughs at fence junction can service four holding yards.

3. Water Use Practice

The volume of water used for washing of livestock varies considerably between plants and between different classes of livestock. Reports range between 30 and 1800 litres per head. (*Wescombe 1995.*) The type and source of cattle obviously influence the quantity of water required to wash them, but the main factor is the procedure, or lack of it, adopted at individual plants. The design of the yards or pens can adversely affect the efficiency of the livestock washing process. Up to 70% of water may be wasted in a poorly designed facility.

4. Supplementary Stock Washing

Dirty cattle should be segregated on arrival at the receiving yards and given a preliminary wash to bring them up to a standard similar to the rest of the mob. This will minimise the amount of washing necessary for the mob as a whole, thus reducing stress to the animals and saving on the quantity of water used.

5. Hose Damage Prevention

Manual washing should be restricted to those cattle requiring extra cleaning as discussed above. A 20 mm to 25 mm diameter hose fitted with a 9 to 10 mm nozzle will maximise efficiency. Large diameter hoses should be avoided as they are cumbersome and inefficient and nozzles are easily damaged when they are allowed to fall onto, or are dragged across concrete floors. Recessing the nozzle either inside the hose or protective tube, or welding a protective disc on the end of the nozzle will help overcome the problem.

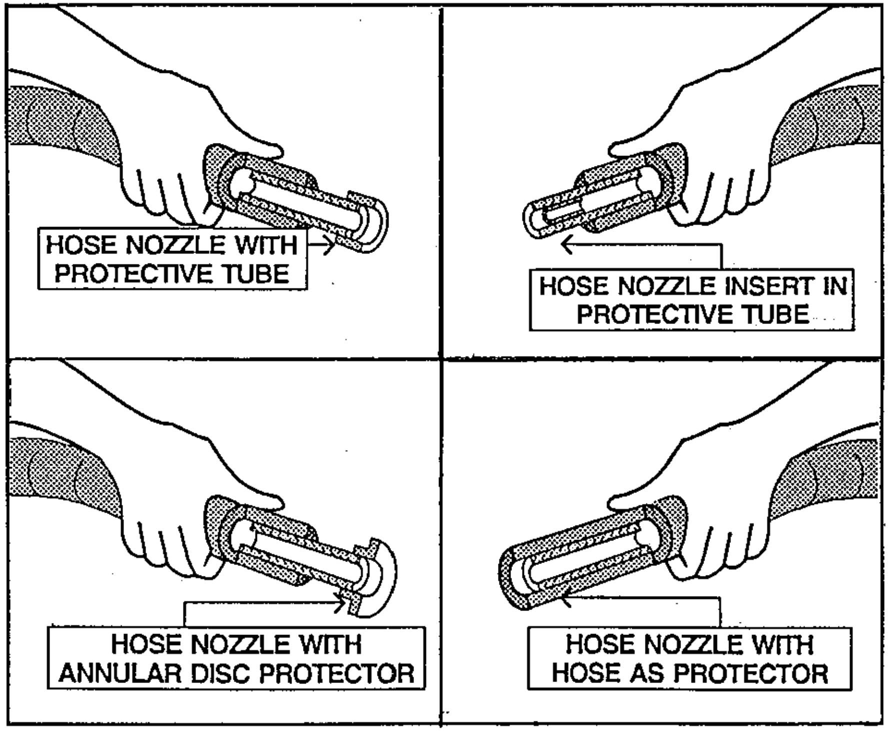

Figure 2.4 Measures to protect hose nozzle from damage.

'Camlock' couplings, or similar, should be fitted to hoses and reticulation outlets in pens where cattle are washed manually. The number of hoses used in these and other areas, should be set to match the labour involved. This avoids spare hoses being left running unattended which besides being wasteful can reduce the effective pressure available at the hoses in use.

6. Minimisation of Pre-slaughter Stress

Pre-slaughter stress is an important consideration in relation to the hosing and washing of livestock prior to slaughter.

> There are three important factors in preventing preslaughter stress in relation to washing:
> - Wash water pressure (10 bar maximum);
> - Holding yard floor design (Suspended mesh);
> - Wash water temperature (Tepid).

- Available water pressure should be restricted to a maximum of 10 bar. Even at this pressure, use of the nozzle in proximity to the animal can leave welts in the flesh.

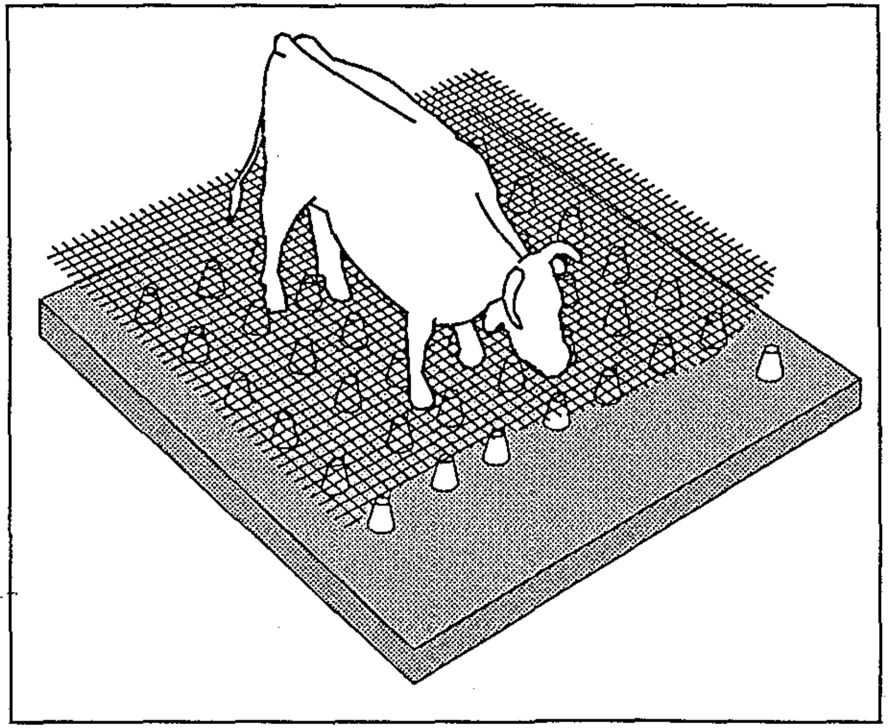

Figure 2.5 Elevated mesh flooring keeps livestock clean and makes yard cleaning more efficient.

- The quantity of soilage on livestock can be reduced by the installation of woven wire gratings mounted clear of the floor. This allows the droppings and urine to fall through the mesh and the livestock to remain relatively clean. Mesh flooring is frequently used in smallstock yards and to a lesser extent in cattle pens. It can be suspended at various heights above the floor. Besides reducing the extent of livestock soilage, it also avoids compaction of manure on the floor of the yards and simplifies cleaning of the concrete floors. These two factors combine to yield a significant overall reduction in water usage in this area of the plant.
- Some plants use tepid water in overhead sprays for stock washing in the lead-up race. This will minimise the stress that can result from spraying stock with cold water. Providing the tepid water can be sourced at relatively low cost then this has merit especially in the colder weather in southern states.

7. Washwater Screening

Stock washing water and yard washing water should be screened to recover solids before discharge of the liquid phase into the effluent system. Screening is best done with:

- Rotary screening unit, e.g. Contrashear or Rotostrainer, with wedge wire at 0.75 mm spacing (Refer Appendix, page 93);
- Static wedge wire parabolic screen unit, e.g. Bauer Hydrasieve or Dorr-Oliver. (Refer Appendix, page 94).

Self-cleaning characteristics of static screens are enhanced when the horizontal wedge wires are formed in a chevron pattern. The solids gravitate to the bottom of the vee and are eventually sloughed off by the water.

Two other points should be considered in relation to solids screening:

- Recovered solids can be sold as fertiliser or combined with other solid wastes before disposal;
- The effluent should not be combined with other liquid waste streams until after final fat recovery at the saveall or dissolved air flotation (DAF) systems.

Stockyards and paddocks

Summary of problems and solutions

Problems	Points to Consider	Solutions
Overflowing drinking troughs	• Muddy yards • Dirty cattle	• Install concrete surround • Adequate drainage
Solids Build-up in Recycled Wash Water	• AQIS Regulations	• Make up water from first wash
Wash water wastage	• Poor washing practice	• Manage washing efficiency • Pre-wash dirty cattle • Suspended mesh yard floor
Animal Stress	• Excessive washing • Water pressure	• Pre-wash dirty cattle • Minimise water pressure
Hose damage	• Reduced washing efficiency	• Recessing nozzle • Protective disk
Wash water solids	• Treatment system overload	• Effective screening

3

Slaughter Floors

Management of water on the slaughter floor cannot be put into a proper perspective without first considering the interaction between water usage and the collection of by-products including:

- Blood;
- Fat;
- Tissue.

> Management of slaughter floor water usage begins with effective collection of by-products and rendering raw materials:
>
> - Blood should be contained and collected;
> - Prevent blood being diluted with washwater;
> - Blood yields should be monitored regularly;
> - Fat should be contained and collected;
> - Prevent fat being washed away at clean down;
> - Reduce tissue loss by controlling (eliminating) carcase wash.

Of all the components of the meatworks effluent stream, blood constitutes the highest pollution load, followed by fat. Raw blood contributes on average 6 kg of BOD for each head of cattle. Blood is also high in nutrients, typically 24,000 mg/L nitrogen and 1,500 g/L of phosphorus *(Johns & Greenfield 1992)*.

Allowing blood and fat into the effluent stream increases the cost of effluent treatment and represents the loss of a valuable product. Every effort should be made to maximise raw blood and fat collection and subsequent processing into blood meal, tallow, or other value-added alternatives.

1. Blood Collection

Design of the sticking area should ensure that all blood is directed into the blood collection facility. Sheep and other smallstock are frequently placed on a table or chute for sticking and suitable splash guards should be installed to prevent fouling of adjacent equipment and structures. Ideally, cattle should not be stuck while they are in the dry landing area or on the horizontal slat conveyor. Sticking should be done once the animal is located over the blood collection facility. Sticking the animal prematurely can result in blood loss into the effluent drains or dilution of the blood with process wash water. An anti-sway device can stop carcases swinging violently when they are stuck on a bleeding rail in the vertical position. Such a device can be either shoulder support bars or rubbing rails.

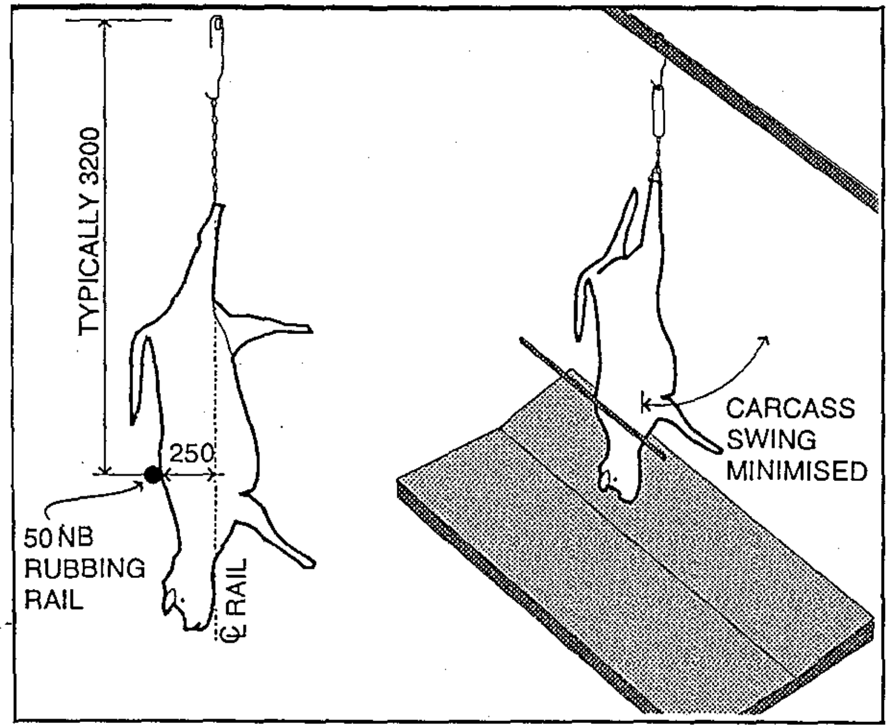

Figure 3.1 An anti-sway device will stop carcasses swinging and contain blood in collection facility.

2. Water Contamination Avoidance

Blood collection can be enhanced by installing a shallow stainless steel trough, set in concrete, under the bleeding rail with a positive fall towards the blood pit. The trough should be of sufficient length to ensure that bleeding is complete before the animal reaches the end. Time required for effective bleeding is dependent on the sticking method employed but will not be less than seven minutes. The ultimate method of blood collection from under the bleeding rail would be a troughed belt conveyor fitted with scraper or doctor blades to continuously recover the blood.

Water contamination of the blood should be avoided. It will reduce the effectiveness of subsequent coagulation and increase the loss of blood solids to the effluent. In processes where the blood is dried without coagulation, the energy required to evaporate the moisture increases. Sources of water contamination include:

- Overflowing hand wash basins;
- Sterilisers;
- Wash down hoses running into the bleeding pit.

The bleeding area of the slaughter floor is the main source of blood contamination in the effluent. The blood collection area, or blood pit, generally has two drain outlets, one to the blood tank or pump and the other to the effluent system. One or the other is always plugged off as appropriate. Blood recovery can be maximised by following a few simple procedures.

- Periodically squeegee any coagulated blood into the blood pit for subsequent processing.
- Slaughter floor processing procedures should specify the standard of blood recovery that must be achieved at completion of slaughtering before changing over to the effluent outlet.
- Procedure should include the squeegeeing of coagulated blood from the sides and bottom of the blood pit and trough.
- Control of the change over plugs or valves should be the responsibility of the departmental supervisor or designated operator who would also give the go ahead to commence washdown of the area.
- Installation of full-flow ball valves on both the blood and drain lines allows for the operating handles to be mechanically interlocked so that as

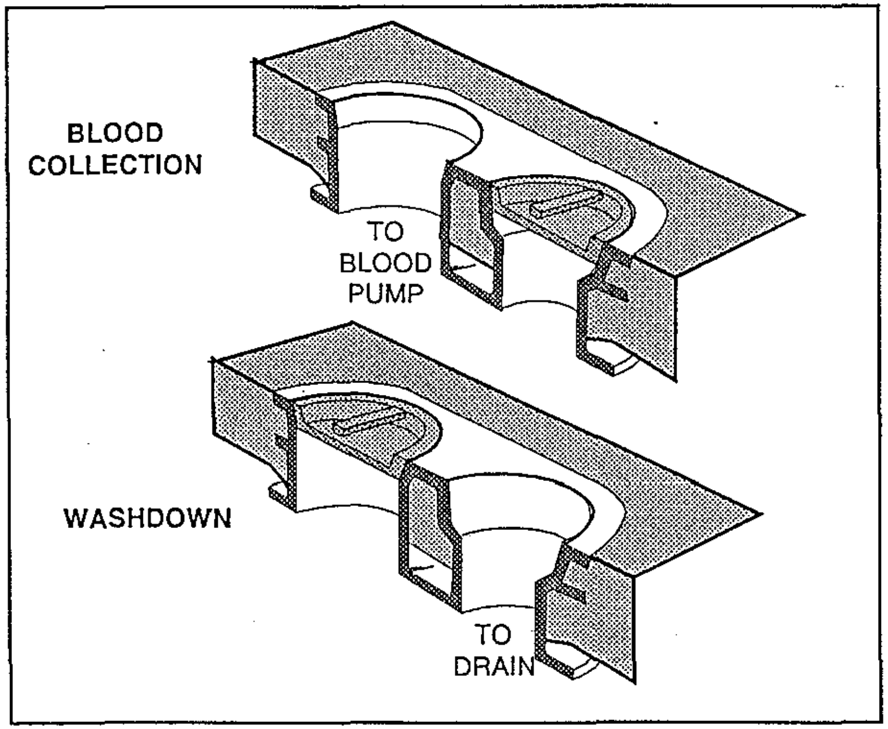

Figure 3.2 Manual plug change over (blood pit/floor drain) should be done by a supervisor or designated operator.

one valve opens, the other shuts. However precautions are necessary to ensure that the valves cannot be left in the mid position where both would be partially open. Indicating lamps energised when the appropriate valve is fully open will provide visual indication of the system status. If the lamp is unlit then either the valves are in mid position or the lamp is faulty, enabling corrective action to be taken.

- Where access is provided below the blood pit, a single outlet from the knocking area with an external diversion to the effluent system is feasible, discharge to the drainage system only occurring after production has ceased. The outlet from the bleeding area incorporates a knock-out pot to trap heavy solids and diversion of the water to drain is achieved by opening the

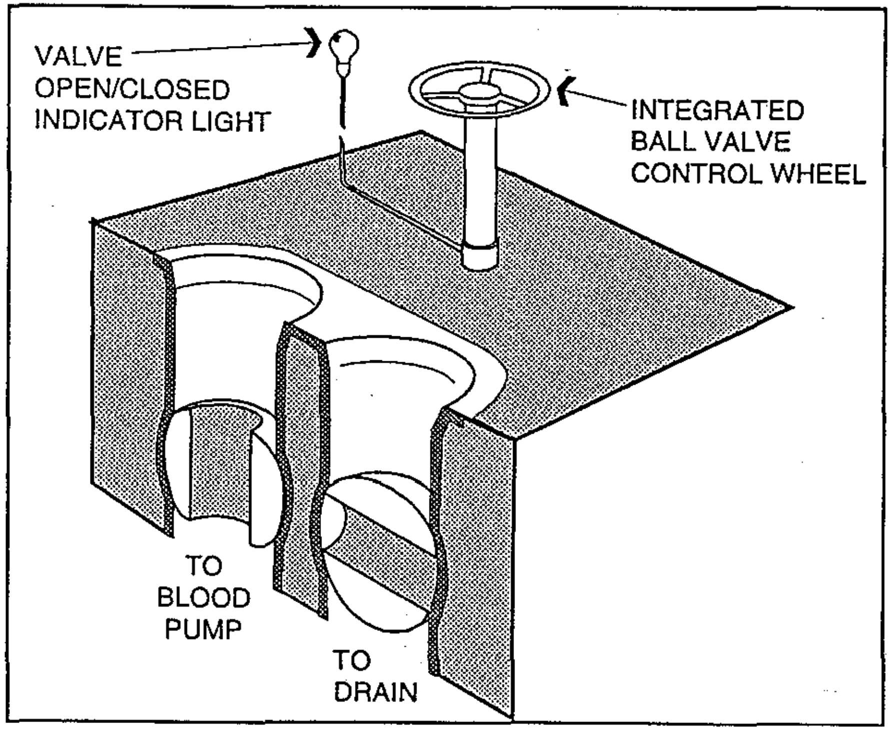

Figure 3.3 Blood pit/floor drain ball valves can be interconnected to avoid incorrect setting.

bottom cover plate, after production ceases. Blockages in the blood pump or transfer lines resulting from an accumulation of cartridges or horn tips can be overcome by providing a suitable strainer which will not be affected by blood clots.

Whatever method is used to prevent unnecessary contamination entering the wastewater stream it is important that the equipment involved be properly maintained and it's usage monitored. The effectiveness of the primary wastewater treatment system will be compromised by excessive loadings in respect of water volume, solids load or temperature (*Husband 1992*). This in turn will have a detrimental effect on the efficiency of pond systems (*Green 1992*) and other subsequent wastewater treatment facilities.

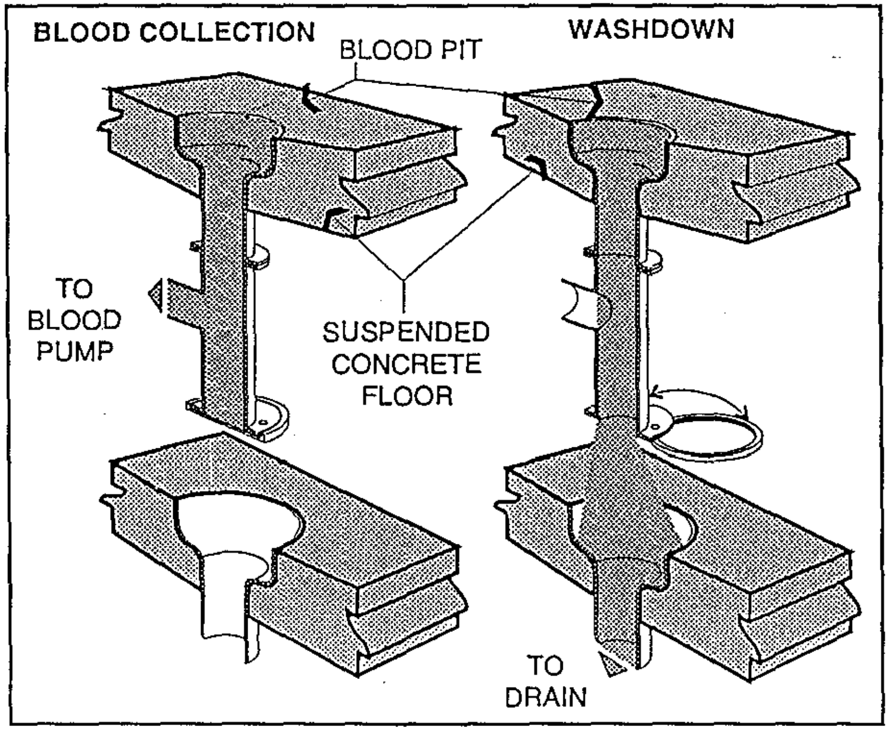

Figure 3.4 Single drainage/blood pit system with blood pump diversion.

> The wastewater system should not be overloaded with:
>
> - Unnecessary water volume;
> - Excessive solids load;
> - High temperature.

3. Blood Yields

Blood recovery yields should be routinely assessed to establish the efficacy of the operations. An increase in the amount of raw blood significantly above that in the following table suggests water addition and conversely, a decrease shows that raw blood is being lost to the effluent system. In both instances there will be a reduction in the quantity of dried blood meal produced.

Yields of raw and dried blood from various categories of Livestock as percentage of dressed carcase weight (*Johnson, 1978*)

Type of Stock	Raw Blood Yield	Practical Dry Blood Yield
Cattle <200 kg	6.3	1.2
Cattle 200-300 kg	5.3	1.0
Cattle >300 kg	4.2	0.8
Bobby calves	7.4	1.4
Pigs (head on)	4.0	0.75
Sheep	7.4	1.4
Lamb	6.9	1.3

4. Fat Yield and Quality

Fat is the next highest pollutant vector after blood and every effort to prevent its loss into the effluent stream should be made:

- Fat subsequently recovered from the effluent system will be downgraded and the longer it remains in the system, the greater the degree of degradation.
- The free fatty acid (ffa) level of the fat increases as a result of moisture, nutrients and temperature conditions ideal for bacterial growth.
- Fat will blind the screens in the effluent treatment system. The higher the fat content in the effluent, the more frequent the cleaning with hot water to clear the screens and this will liquefy the fat, transferring the problem downstream.

5. Sources of Fat Loss

- Caul and kidney fat removed from the carcases on the slaughter floor is usually deposited into bins or chutes for conveying to either edible or inedible rendering departments for processing. Small plants can use receptacles such as tote boxes to collect this material.

- Trimmings are removed at various stages during carcase dressing in order to meet final product specifications. If these trimmings are allowed to fall on to the floor the quality of the fat is downgraded and some will inevitably find its way into the effluent system where further degradation occurs.

During carcase washing, loose tissue, blood clots and fat pieces are washed from the carcase or side. The quantity of each is dependent on various factors, but the water pressure and spray nozzle type has a direct bearing on the amount lost. The water pressure should be at the minimum required to achieve the desired result. The trend away from carcase washing at some plants must be applauded as a 'step in the right direction', with more emphasis being placed on the removal of visible contamination by trimming. This may require more stringent attention to the effectiveness of the integral water spray at the carcase splitting saw to ensure adequate removal of bone dust.

Slaughter floor by-product losses (fat, blood, tissue)

Summary of problems and solutions

Problems	Points to Consider	Solution
Low Blood Yield	• Not contained in Blood area • Mess on kill floor • High effluent load • By-product loss	• Correct sticking practice • Effective containment & collection system • Carcase sway prevention
Water in Blood	• Costly evaporation • By-product loss • Excessive effluent loadings	• Squeegee blood, do not hose • Specified 'dry' cleanup standard, before hosing • Supervise control of valve blood/effluent drain
Low Fat Yield	• Not contained by collection system • Washed from equipment during clean down • Excessive effluent loading • Tissue washed away during clean down	• Control water pressure • Minimise carcase washing • Use effective floor drain screens

The importance of blood, fat and tissue loss avoidance, has been clarified in the context of water usage management. Other elements of the slaughter floor water usage include hand basins and sterilisation units. These can be large users of water and they are also a significant source of heat in the effluent stream.

6. Wash Basin/Knife and Equipment Sterilisers

- An adequate number of handwash basins are mandatory at work stations on slaughter floors and in processing rooms. Hand basins require hot water, at between 35°C and 43°C, in sufficient quantity, typically 15.0 L/min, to ensure that there are no unnecessary production delays especially on the slaughter floor. Water supply is conventionally thigh or pedal operated (see Appendix page 90). Microprocessor controlled units are now available. Interruption of an infra-red beam causes the water to flow for

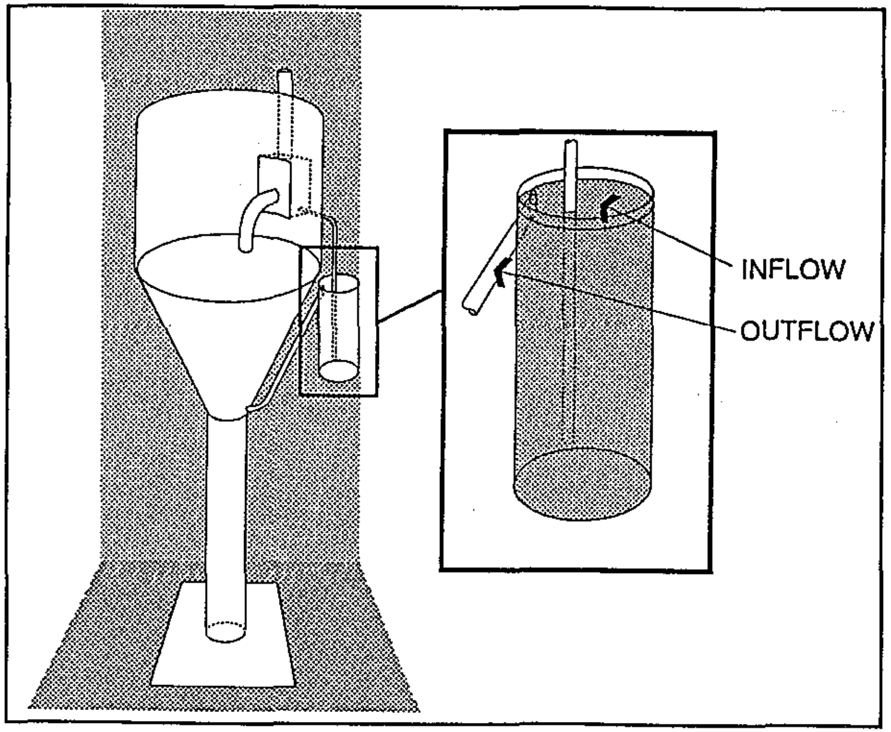

Figure 3.5 Conventional steam injection steriliser.

A predetermined time. These units overcome the problem of water wastage such as can occur due to tying down of the controls of manually operated units (see Appendix page 91).

- Water at 85°C, overflowing at 0.6 L/min, is usually sufficient to maintain bowl type knife sterilisers at the required operating temperature of 82.2°C, irrespective of ambient temperatures. Double-skin insulated steriliser bowls have two benefits compared to conventional units, they minimise water consumption by minimising heat loss and they reduce the risk of injury from accidental contact. In areas with very hard water, a higher flow may be necessary to minimise calcium build up and prevent blockages in small bore supply piping. Electrically heated sterilisers are an option in this situation.
- Electrically heated sterilisers are double skin insulated bowls with a 750 W electrical element maintaining the required water temperature. All blood and protein should be rinsed from knives before sterilising in electric sterilisers, in order

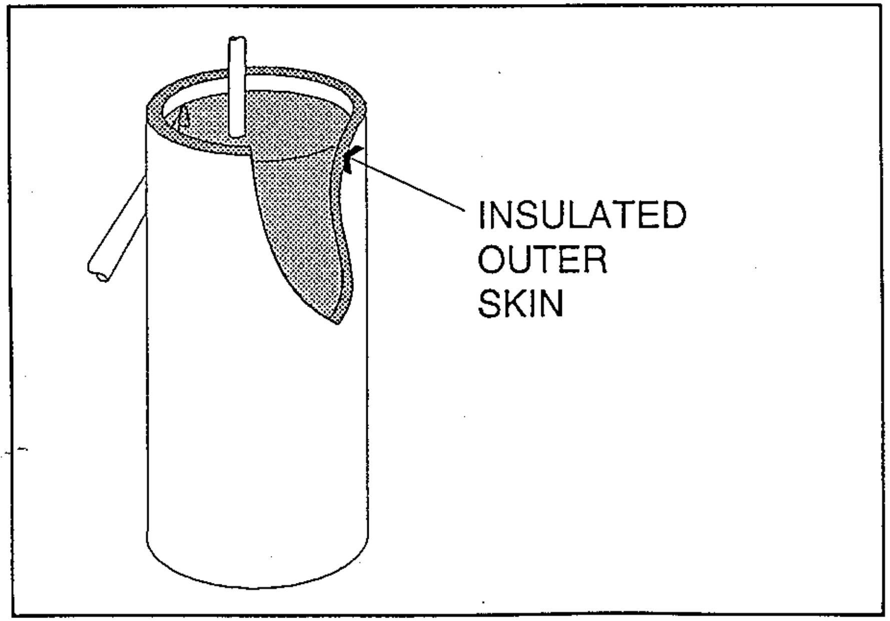

Figure 3.6 Jacketed steriliser – reduced heat loss/improved safety.

To extend the period between water replenishment or replacement.

- EU regulations stipulate a minimum of five bowl changes per hour. With a 3-litre bowl this is equivalent to 15.0 L/hr compared to 36.0 L/h for a conventional bowl steriliser. The logistics of changing the water every 12 minutes must be taken into consideration in EU registered plants.
- The EU requirement for a two-knife system increases the contact time and achieves effective sterilisation at lower water temperature. There are sound technical reasons therefore to reduce the water temperature in bowl sterilisers on EU listed plants. However any variation to the AQIS regulations would depend upon submissions on alternative procedures, fully supported by scientific analysis, to importing countries for approval. This is unlikely to occur in the foreseeable future.

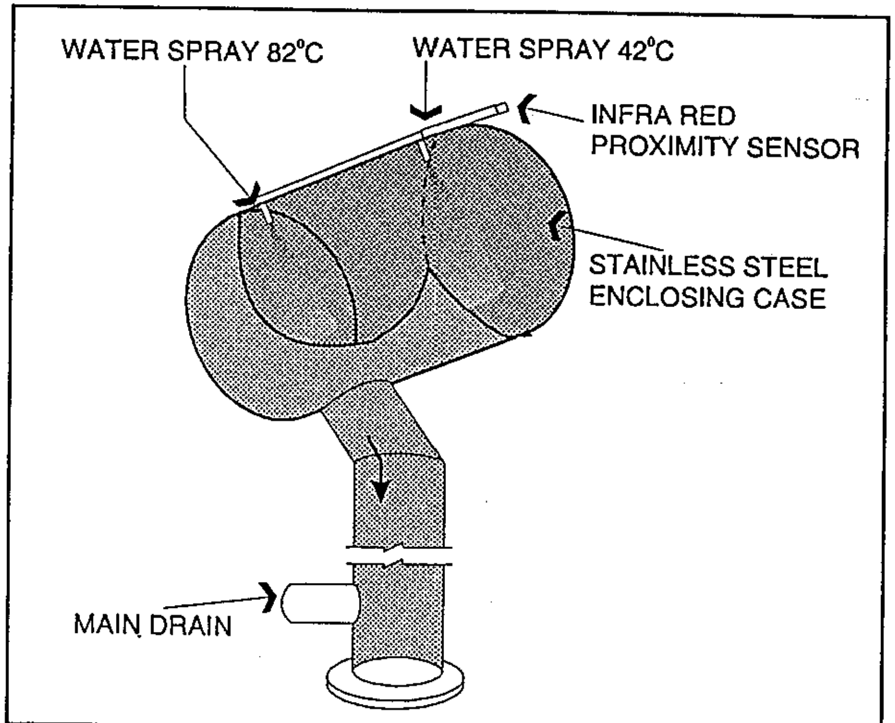

Figure 3.7 Large item spray steriliser – solenoid/timer control.

- Spray type implement sterilisers should have properly engineered nozzles to achieve effective cleaning. Non-atomising nozzles should be selected for high water impact and low flow rates. To minimise water consumption, continually running sprays should be avoided and water flow should be triggered by the introduction of the implement into the unit. The sprays should run for a preset time consistent with regulatory requirements. (NZ authorities are preparing a CODEX submission for the use of chemical sterilisers in lieu of hot water).
- Control of the steriliser flow rate should not be left to individual operators. A responsible person should be appointed to adjust each unit to the required maximum flow and the valve should be secured at this setting, A secondary valve installed in series can be used to simplify the isolation of individual units.

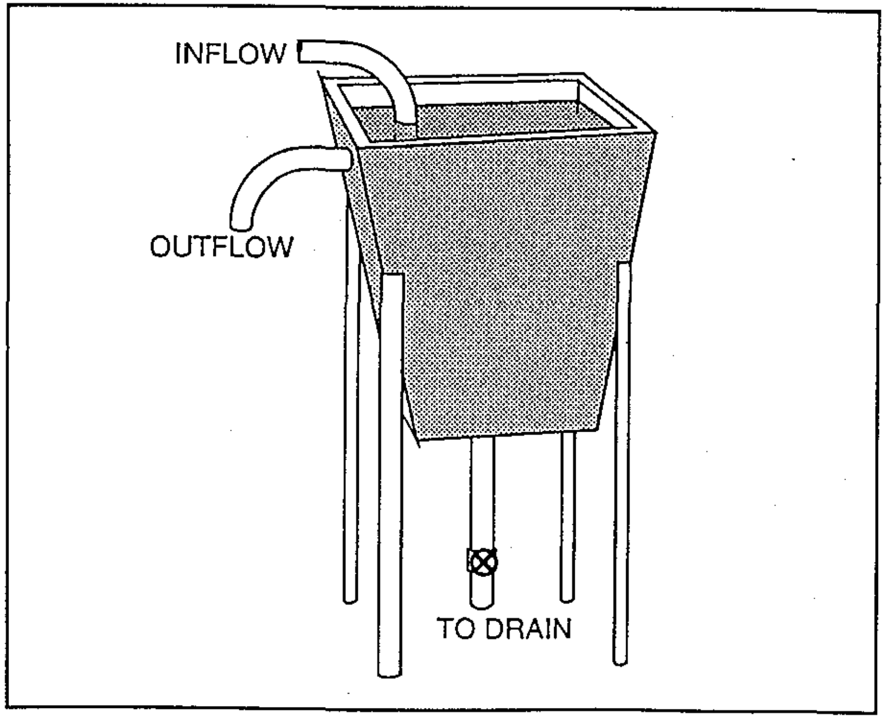

Figure 3.8 Large item steriliser – plunge bath type.

- A solenoid valve installed in the ring main supply line can isolate all sterilisers in the department. This should be shut off by the supervisor during smokos, meal breaks and at completion of slaughtering operations.

Flow rates should be checked at least monthly. A simple flow measuring device consists of a small cylinder with an internal mesh basket, to reduce water turbulence, and a narrow vertical discharge slot. The device works on the principle of a square edge thin plate orifice and is individually calibrated at known flow rates.

The pot is held under the water stream to be measured and the flow rate read off the scale on the side of the vertical notch. The scale can be etched directly onto the pot or, alternatively, an adjustable scale can be mounted alongside the slot. This latter arrangement provides for more accurate adjustment and readings. The capacity

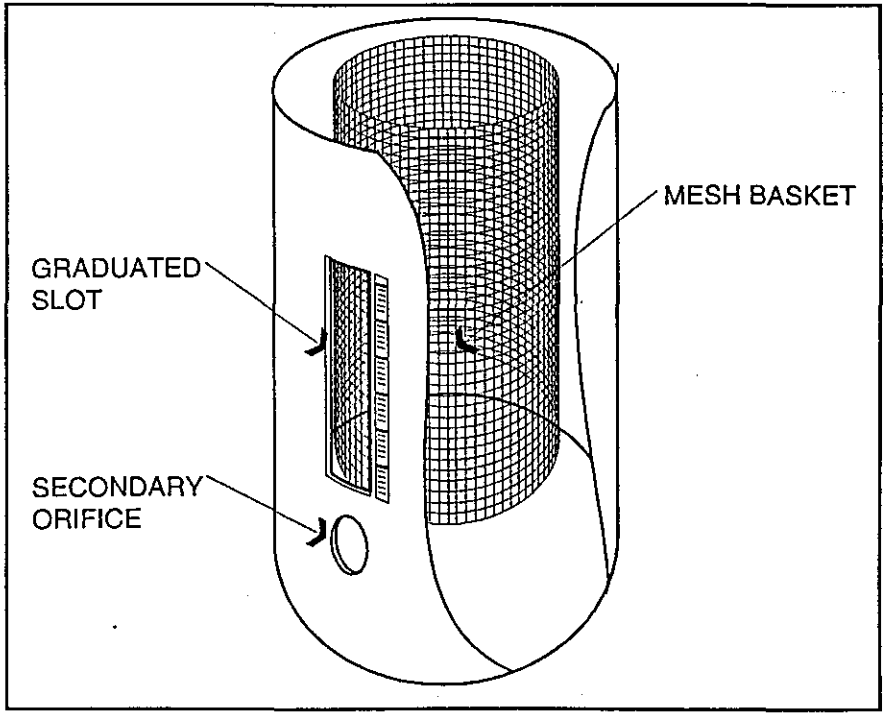

Figure 3.9 Hand held flow measurement pot.

range of the device can be increased by providing a secondary orifice, 15 mm diameter, below the level of the vertical notch. A removable plug is inserted in this orifice when measuring low flow rates and removed for measuring high flow rates.

Water flow control devices are available commercially, including restrictors that can be readily inserted into the pipeline immediately upstream of the outlet. (refer Appendix page 89). A variety of water conserving shower roses are also available and these should be selected for appropriate applications.

Hand basins and sterilisers

Summary of problems and solutions

Problems	Points to Consider	Solutions
Hand basin water wastage	• Unsuitable valve operating mechanisms • Tying down manually operated shut-off valves • Damaged foot-operated valves	• Knee or thigh operated valves • Remote sensing valves, e.g. infra-red
Knife/Steriliser water wastage	• Excessive overflow rate • Heat losses from steriliser bowls	• Measure and control overflow rate • Rinse knives before sterilising • Use double skin steriliser bowls
Hard water supply	• Calcium build-up blockage in supply line	• Increase water flow • Use electric sterilisers
Spray steriliser water wastage	• Water atomising, misting • Excessive water use	• Use Non-atomising, high impact, low flow nozzles • Auto triggering and cut-off valves triggered by implement
Heat wastage	• Excessive water temperature • Excessive water use • Effluent temperature problems	• Measure and adjust temperature • Control hot water shut-off valve

7. Slaughter Floor Equipment (All Species)

Excess water consumption can be related to constant running items being left operating unnecessarily. Constant running items include; sterilisers, wash units and material transfer facilities.

Constant running items of equipment that use significant quantities of water:

- Viscera conveyors;
- Knife sterilisers;
- Carcase washers;
- Chute lubrication;
- Wash trommels;
- Head washers.

It is not uncommon to find these items left running from the cessation of production until washdown is completed. This may be four to six hours later. Viscera tables are especially large water users.

Water consumption rate for viscera tables *(Spooncer & Barkley 1984)*

Species	Cold Water	Hot Water (82°C)
pigs	150 L/min	65 L/min
mutton	235 L/min	223 L/min
beef	193 L/min	121 L/min

Ideally water lines should be divided into two groups, which should be reticulated separately, e.g. constant running and intermittent streams. The water supply to the constant running items should be fitted with solenoid valves, preferably controlled from a central point, which should be switched off by the supervisor during smokos, meal breaks and at the end of production.

Duel reticulation of potable water supply will allow separate control of:

- Constant running items;
- Intermittent running items.

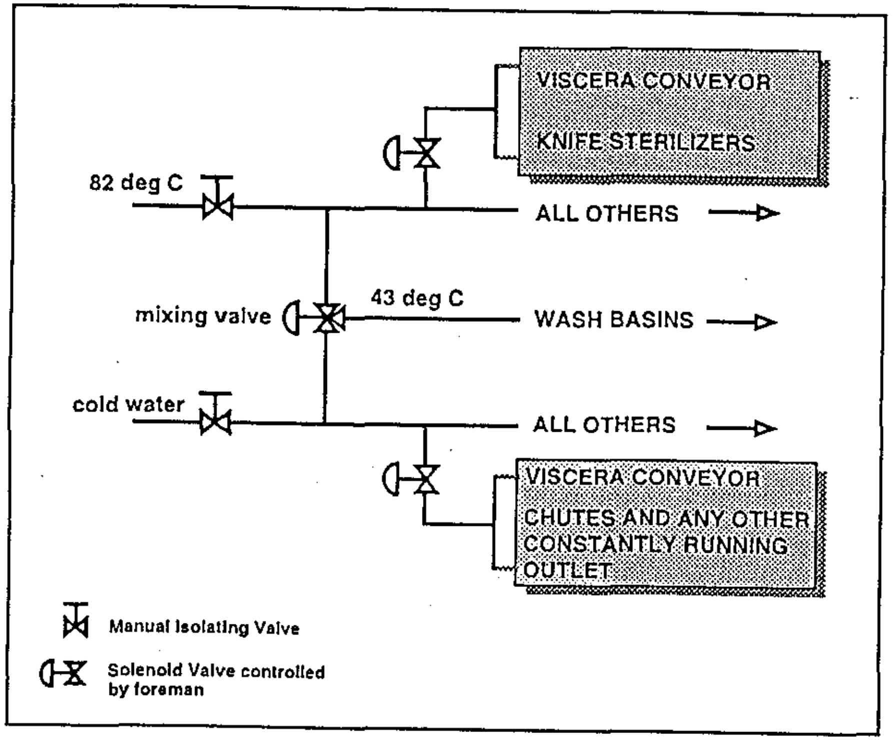

Figure 3.10 Central control of constant running items.

Motion sensor control of solenoids is another viable alternative. A number of sensors strategically located along the overhead conveyor system can be energised by the skids or rollers. The sensors are connected in parallel and energise the solenoid valves via a time switch, this de-energises the solenoids and shuts off the water flow after a preset elapsed time following the last sensing. The solenoid valves are thus unaffected by empty conveyors running during washdown.

On larger slaughter floors, the water supply can be segregated into a number of zones individually controlled by solenoid valves and motion sensors, thus the water will be progressively turned on to each section as the first carcase proceeds along the dressing conveyor. At the end of production the reverse occurs, water shuts off as the last carcase clears each zone.

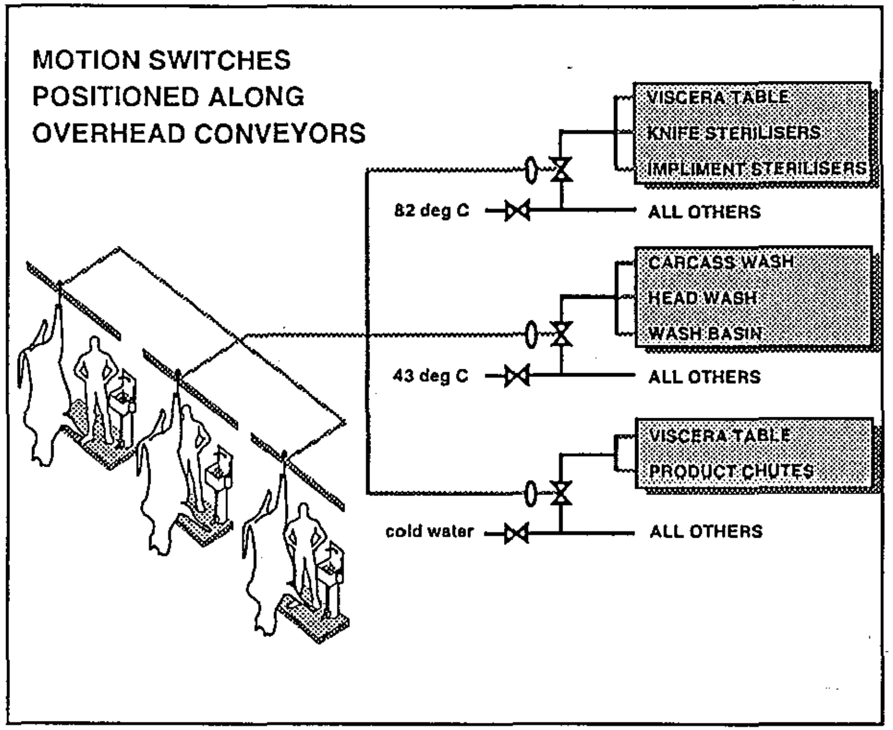

Figure 3.11 Motion sensor control of constant running items.

Slaughter floor – general water use

Summary of problems and solutions

Problems	Points to Consider	Solutions
Water wastage from constant running equipment (listed above)	• Equipment can be identified as: Supervisor controlled, or Worker controlled	• Supply centrally controlled by supervisor • Separation of 'constant' and 'intermittent' streams
	• Supervisor control can be automated	• Control solenoid in ring main • Conveyor sensors on chain to activate constant running equipment
	• Damaged foot-operated valves	• Remote sensing valves, e.g. infra-red.

One area of significant water usage on conventional slaughter floors is the carcass wash. The present trend in the meat industry is to reduce the extent to which carcasses are washed. The EU has a policy of minimising the application of water to carcases and is opposed to pre-evisceration washing of smallstock. The final wash is still accepted providing the works can demonstrate that there is no spread of contamination over the surface of the carcase. Opportunities exist on many plants to reduce water usage by modifying carcass washing practices.

> The large automatic carcass wash... Is it necessary?

One distinct advantage of the modern carcass band saw is that 'bonedust' no longer comprises a mass of small bone chips that are difficult to remove. Rather the residue is more like a paste that can be removed with minimal washing, so the amount of water necessary to clean a carcass is reduced significantly.

8. Slaughter Floor Equipment (Individual Species)

Much of the equipment and many of the practices employed in a slaughtering and dressing operation are common, irrespective of the species being processed. There is merit, therefore, in presenting water utilisation reduction measures mostly in a generic manner so as to apply to all plants. Obvious differences do exist, however, between species, and the following sections will deal with aspects of the operation that need to be considered separately.

> Slaughtering/Dressing functions that impact on water usage:
>
> - Blood recovery;
> - Carcass washing;
> - Spray nozzle wear;
> - Pig scald dumping.

Species groups that will be considered separately are:

- Beef;
- Sheep, goats and other small stock;
- Pigs.

Beef Slaughtering

There are a number of aspects of the beef slaughtering and dressing operation that have a significant impact on overall water usage.

Blood Recovery

When an animal is stuck by severing of the carotid arteries there is a sudden release of blood. Bleeding rate is enhanced by low voltage electrical stimulation. The volume of blood gradually diminishes with time, and after about seven minutes it slows to a trickle. Blood loss continues during subsequent dressing operations up to the point of hide removal, and it is most noticeable at the head removal station.

Recovery of blood on the slaughter floor is often ignored and it ends up in the effluent system. However belt conveyors or stainless steel troughs can enhance recovery.

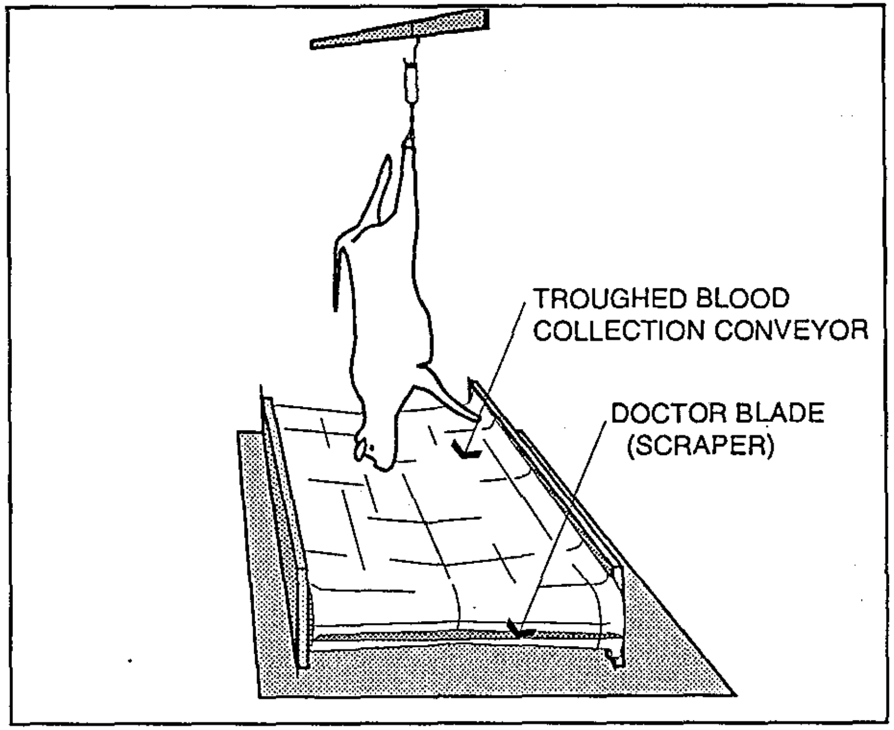

Figure 3.12 Belt conveyor for blood collection.

- A belt conveyor under the bleeding rail, discharging into the blood pit, is the most effective method of continuously recovering the blood. This is at the expense of some increase in water consumption due to cleaning requirements for the belt itself. The length of the conveyor should be at least equal to the distance travelled by the carcase in seven minutes from the point of sticking. To effectively contain the blood the belt should either be troughed or have side skirts. The latter is more adaptable to hygienic design of the conveyor frame to simplify cleaning. Doctor blades, or scrapers to continuously recover the blood from the conveyor, and fixed spray nozzle distribution headers for efficient cleaning of the conveyor belt and frame should be installed to minimise water consumption.

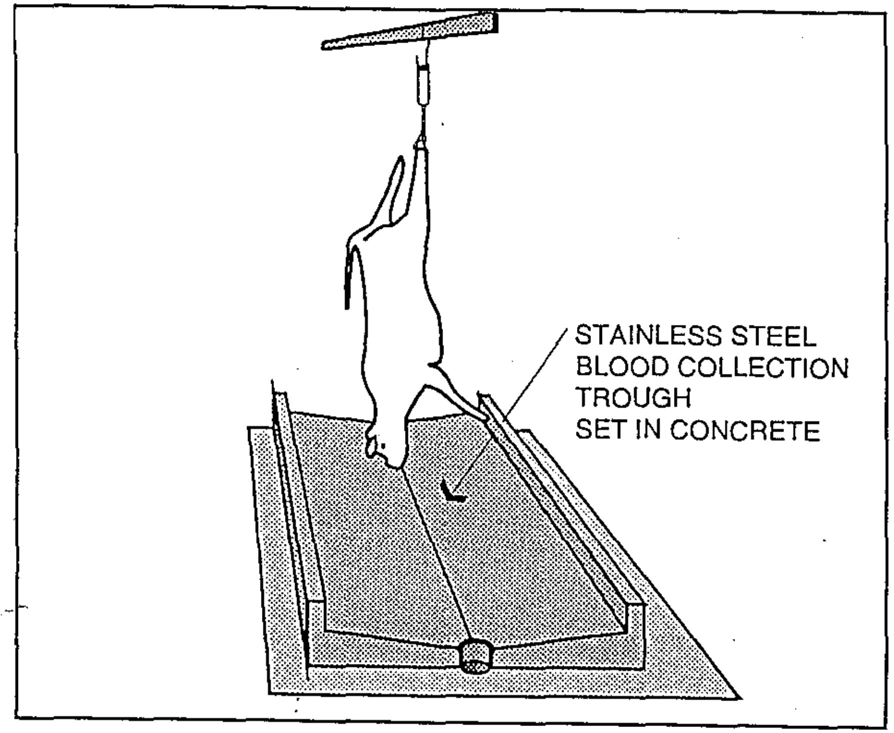

Figure 3.13 Stainless steel blood collection trough set in concrete.

- A shallow stainless steel trough under the bleeding rail, extended through to hide removal, is another method of improving blood recovery. The trough should be set in concrete and elevated about 100 mm above the floor level to exclude general wash water and to enhance cleaning. The fall in the floor should be directed away from the dressing line. The trough should be inclined towards the blood pit, and auxiliary drain outlets should be provided, as required, along its length. The required frequency of squeegeeing the coagulated blood from the trough will depend on the individual installation and the rate of production.

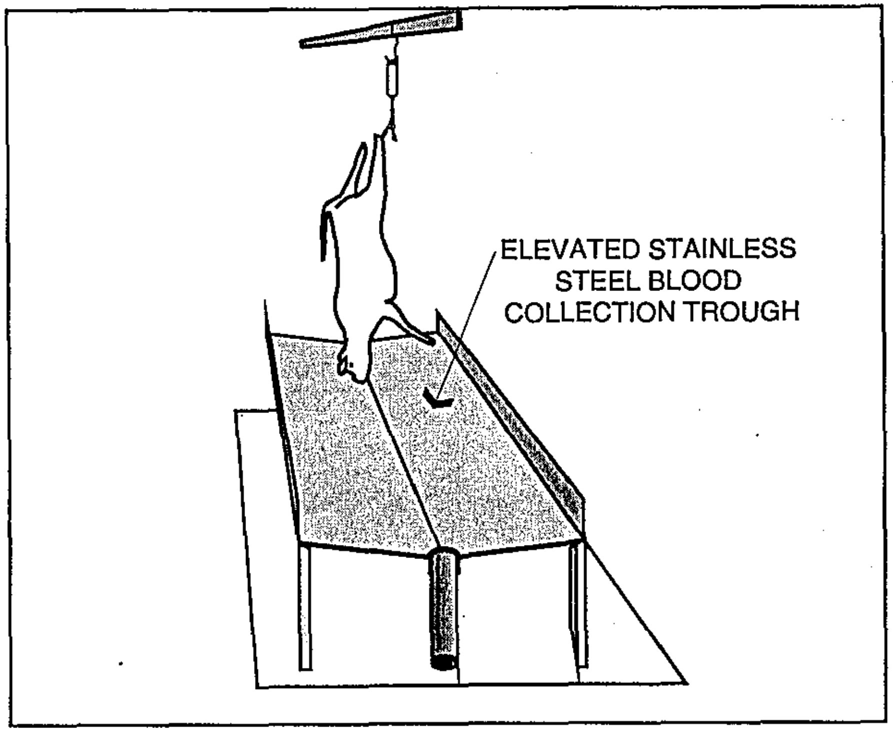

Figure 3.14 Elevated stainless steel blood collection trough.

Carcase Washing

Carcase wash systems can be a significant source of water wastage and effluent contamination. Consumption can range from 50 to 120 kL per day (*Anon 1992*) depending on the method employed. It is difficult to train operators of manual systems to turn off the water spray when the side or carcase is clean. There is a tendency for them to continue washing unnecessarily. The sprays in an automatic cabinet can be operated by the skid or roller so that they are only activated when a side is in the cabinet.

- Pump pressures higher than 10 bar can force surface contamination into the soft subcutaneous fat on the carcase and blast fat from the surface. This fat, together with other tissue washed from the carcass, ends up in the effluent system. Wash water temperatures higher than 30°C, combined with high water pressure, can cause unnecessary fat loss to the effluent.

Spray Nozzles

Spray nozzles are subject to erosion that causes irregular wear of the orifice resulting in distortion of the spray pattern. This increases flow rate and decreases the effectiveness of the spray. Nozzles are available in different materials with different abrasion resistance ratings. The abrasion resistance ratings of selected materials are outlined in the following table.

Nozzle Materials and Abrasion Wear Index

Material	Abrasion Wear Index	
Brass	1	(poor)
Stainless Steel	4 to 6	(good)
GRP	4 to 6	(good)
Ceramic	90 to 200	(excellent)

A 10% nozzle wear = 20% increase in water consumption. (*Anon 1992*)

- Regular visual monitoring for spray nozzle wear should be incorporated into the maintenance program. The necessary frequency of this inspection will be determined by the circumstances of each application.

- Nozzle wear is usually gradual and not necessarily obvious, however an uneven spray pattern will indicate wear. Nozzles in service can be compared with new nozzles to determine the extent of wear. The rated capacities are detailed in manufacturers' brochures, they are specified at various operating pressures (refer Appendix page 94). The flow rate of any nozzle, worn or otherwise, can be determined by measuring the time taken to fill a drum or container of known volume.

Sheep, goats, and other small stock slaughtering

Areas of water usage on Smallstock slaughter floors are similar to those on beef slaughter floors

Blood Recovery

Design of the blood collection area is dependent on the method of slaughter employed. AQIS regulations allow the following smallstock slaughter methods:

- Restrainer box;
- Restrainer conveyor;
- Killing pen.

Whatever method is used, blood recovery will be maximised by periodic dry cleaning of the blood pit, chute or collection area throughout the day and especially before washdown at the end of production. With smallstock, as with beef, it is important to ensure that the blood is not diluted by the inadvertent addition of water from hoses, overflowing handwash basins or sterilisers. Deliberate blocking of the waste outlet in a handwash basin is a common means of creating a readily accessible plunge bath for sticking pen operators to wash blood off the forearms. Supervisors should discourage this practise and investigate the reason it is being done. It is possible that an ineffective shower rose or water outlet is not removing the blood quickly enough.

> An inadequate Water Supply for a particular facility (e.g. wash basin) will result in excessive water being used elsewhere (e.g. hose) as an alternate measure.

- Inverted dressing systems for smallstock often incorporate dressing of the carcase in the horizontal position. Low voltage electrical immobilisation enables dressing to start before completion of bleeding. In this situation the blood trough can be installed at a height that will contain the blood and minimise soilage of personnel.

- Ritual slaughtering of bobby calves may result in ineffective severing of both carotid arteries. This slows the bleeding process and extends it beyond the blood collection facility. Blood loss to the effluent system is inevitable.

Wool Recovery

- During sheep and lamb dressing, wool falls on to the floor and invariably ends in the effluent system. Drains should be fitted with strainers to intercept this wool to facilitate its collection and separate disposal (refer Appendix page 92). State of the art technology in plumbing and floor waste design includes lightweight stainless steel units with integral strainers to suit most applications.

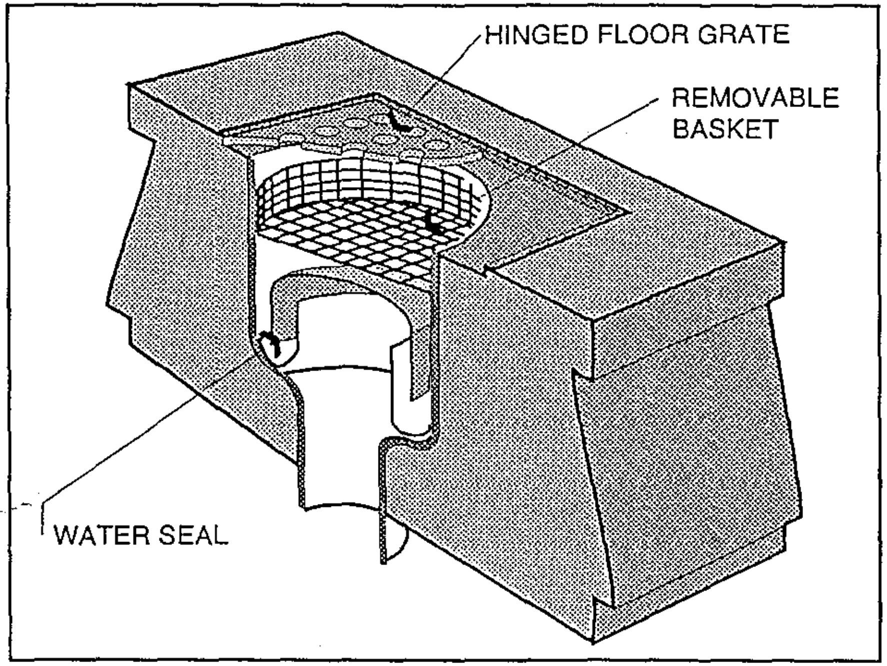

Figure 3.15 Floor drain strainer designed to prevent blockages.

Carcase Washing

- Pre evisceration carcase washing should be minimised, (it is prohibited on EU listed plants) because it spreads contamination over the surface of the carcase. Sheep and lambs are not as susceptible as cattle, to water penetration of the subcutaneous fat layer during carcase washing, however high pump pressure can still force wool under the fat.
- The final wash is currently allowed by all inspection authorities and importing countries. The wash can be either manual or automatic, but given that it is mainly cosmetic, automatic cabinets with sprays activated only when a carcase is in the cabinet are the most appropriate.

Pig Slaughtering

Scalding

- Scald tanks or in line scalding cabinets provide the first stage in the dehairing process. Scald tanks should not be directly dumped to the effluent system because the sudden release of large quantities of hot water at greater than 75°C. will melt fat and allow it to pass through the primary effluent screening system. Direct release should be avoided by providing either a surge tank or controlled discharge from the scald tank. Water can be recycled in multi bank scald cabinets provided fresh potable water is used in the final spray bank.

De-hairing – hair recovery

- De-hairing procedures can result in substantial quantities of hair dropping on to the floor where it can enter the drainage system. Strainers should be fitted to floor drain outlets to collect the hair in order to avoid blockages. Floor drain strainers should only be removed by authorised personnel.

Strainers should be fitted to floor drains to collect:

- Wool;
- Hair;
- Tissue (trim).

Slaughter floor – blood recovery

Summary of problems and solutions

Problems	Points to Consider	Solutions
Build-up of blood in blood pit	• Blood drain may become blocked • Tendency to use water to mobilise blood	• Regular dry cleaning of blood pit • Isolate blood pit from floor drains • Ban hoses in blood pit
Ineffective sticking extends bleed time	• Blood on kill floor outside blood pit	• Extend blood collection facility
Excessive blood on kill floor	• Manpower to recover blood • Excess blood in effluent stream	• Belt conveyor with scraper • Stainless steel trough with squeegee

Slaughter floor – carcase wash

Summary of problems and solutions

Problems	Points to Consider	Solutions
Regulatory requirement	• EU disallow pre-evisceration washing of small stock	• Improve dressing standards
Water entrapment Contamination entrapment Tissue/Fat loss	• Excessive washing either manual or automatic • Water pressure too high • Water temperature too high • Fat and tissue in effluent	• Selective washing of carcases/sides • Automatic wash cabinet • Water pressure less than 10 bar • Temperature less than 30°C

Slaughter floor – spray nozzles

Summary of problems and solutions

Problems	Points to Consider	Solutions
Inappropriate spray pattern	• Different spray pattern needed for different applications, e.g. carcase wash, offal wash, equipment sterilisation	• Choose spray carefully
Loss of water by misting	• Atomising nozzle unsuitable for meatworks applications	• Select high impact, low flow nozzles
Spray nozzle wear	• Increased water consumption • Reduced wash effectiveness • Nozzles available in different materials	• Choose high (>4) wear index material (brass generally no good) • Monitor spray performance

4

Cooling Floors, Marshalling Areas, Cut-down Areas and Boning Rooms

1. Trimming and Solid Waste Collection

A variety of materials constitute solid waste in the post slaughter floor area of the plant. Solid waste includes:

- Trimmings;
- Damaged cartons;
- Polystyrene strapping;
- Polyethylene.

Wherever possible, operators should use tubs, tote boxes or other suitable means to collect solid waste. None of this material should be allowed to fall on to the floor.

- Trimmings and fat pieces trampled into the floor are downgraded and difficult to remove. Excess water is therefore required to clean the floor.
- Belt conveyors should be installed for the collection of fat and trimmings in boning rooms. Depending on the layout of the boning room, conveyors may be installed just above floor level or overhead.

2. Band Saws

Band saws or air saws used to aid tasks such as quartering or the removal of bone-in cuts, generate large quantities of bone dust. Collection of bone dust can be improved by installing suitably designed trays beneath the saw tables. The trays should incorporate wiper blades to clean the saw blade. The wiper blades should be positioned to direct the bone dust into the collection tray.

- The bone dust and other solids should be recovered by squeegeeing before any water is used at washdown.

3. Dry Cleaning

Departmental washdown should be preceded by dry cleaning. Solids should be swept scraped or squeegeed from all surfaces, including boning, slicing and packing tables, cutting boards, work platforms and floor areas, before any surfaces are hosed with water.

Industrial vacuum cleaners have been used successfully in boning rooms for dry cleaning operations (refer Appendix page 96). Solids may have to be loosened and scraped free from surfaces to improve recovery efficiency The vacuum cleaner can then be used to collect the solids for transfer to rendering.

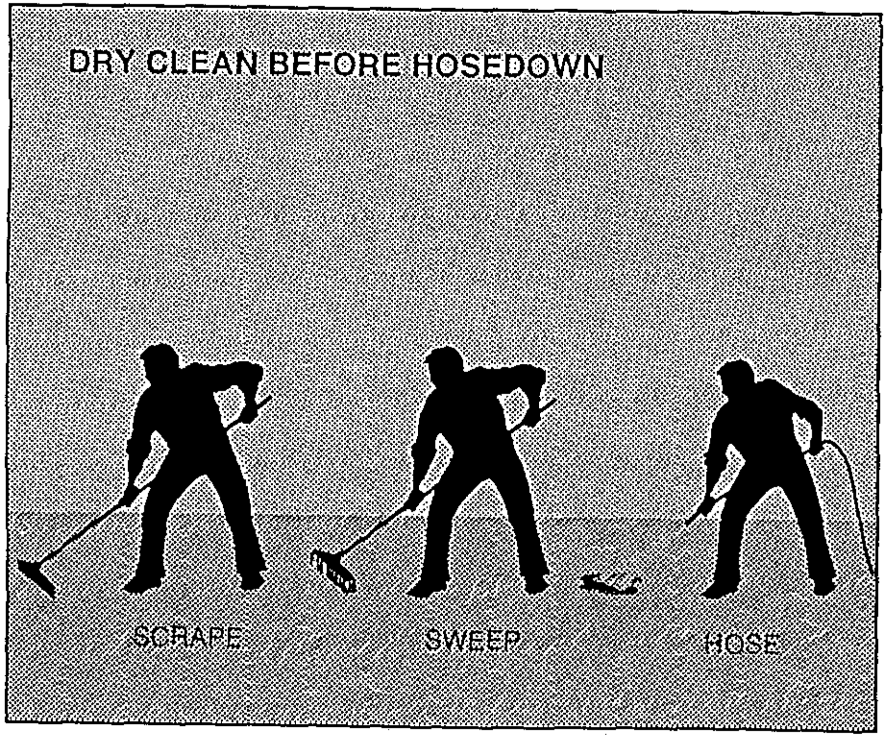

Figure 4.1 Dry clean – scrape, sweep – before hosedown.

4. Washdown

Following thorough dry cleaning, the work surfaces, walls and floors have to be wet in preparation for cleaning and sanitising.

- The lowest pressure and volume of wash water, consistent with achieving the required hygiene standard, should be used.
- Flat jet nozzles provide maximum impact and velocity for any given pressure. Spray angles up to 60° provide wide coverage and a sweeping effect to propel remaining solids towards the floor drains.
- Ineffective cleaning can result from the wrong washdown sequence, and can result in excessive water usage.

> Washdown should always be preceded by Dry Cleaning

Elevated work platforms should be washed first, followed by floors and then walls.

Procedures should be set to ensure that there is no splashing from dirty to clean surfaces, this is especially important during final rinsing.

Cooling floors, marshalling areas, cut-down areas and boning rooms

Summary of problems and solutions

Problems	Points to Consider	Solutions
Disposed of Solid Waste	• Downgrading of fat and trimming on floor • Untidy accumulation of packaging waste • Difficulty cleaning area	• Collect separately all solid waste
Band saw residues	• Recovery of valuable material • Potential effluent stream loading	• Fit band saws with collection facilities
Effective cleaning with minimum water usage	• Suitable cleandown equipment • Appropriate cleaning sequence	• Limit water pressure and volume • Fanjet nozzle (60° fan) for optimal effect • Wash in order of: stands, then floors, then walls.

5

Edible Offal and Petfood

Manual washing of offal has potential for high water consumption if the sprays are left running continuously. Usage can be reduced by using a knee or thigh operated valve in the water line. Another device that has been used in the meat industry (although no current supplier could be located) is a modified kink-it valve arrangement. These valves could be used for washing offal. They were commonly used in casing processing for identifying perforated casings (sprinklers). The valve mechanism is contained in a self-centering flexible tube. It opens when the tube is bent or deflected and closes when it is released. In the modified version a stainless steel ring, approximately 300 mm diameter, could be attached to the outlet of the tube. The assembly would be mounted at a suitable height vertically above the washing table so that the valve would open when the ring is deflected by the operator's forearm.

1. Solids Removal

Both manual and mechanised washing of offal can result in solids loss to the effluent system. This can be minimised by discharging the drain water over a static wedge wire screen with the recovered solids being transferred to the rendering department along with other material. The installation of a mini DAF (dissolved air flotation) tank or CPI (corrugated-plate interceptor) module (refer Appendix page 89) should be considered when the screened drain water has high suspended solids content.

> Solids from Offal washing should be collected by:
> - Static wedge wire screen;
> - Dissolved air flotation;
> - Corrugated-plate interceptor.

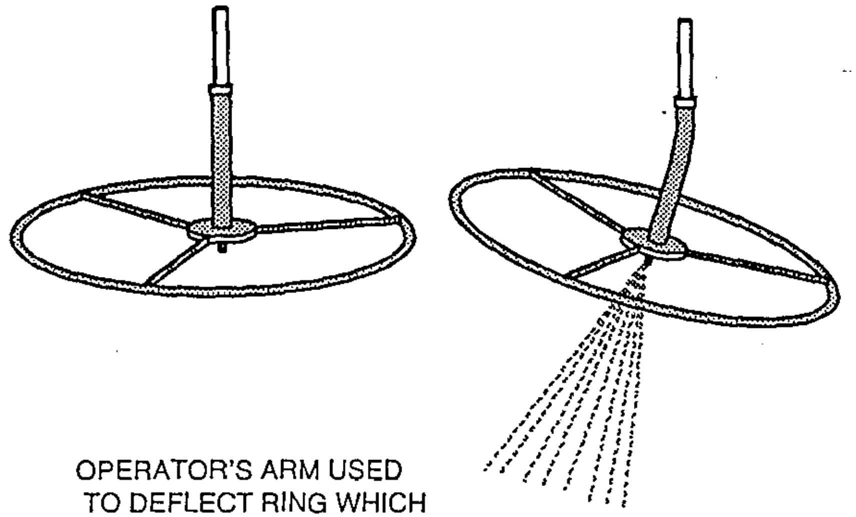

Figure 5.1 'Kink-it' valve for offal washing.

The CPI technology was developed for multi-phase liquid and solids recovery based on enhanced gravitational separation. It consists of a tank containing corrugated plate modules arranged in vertical or horizontal configuration. The drain water flows through the plates which are closely stacked. The light and heavy phases diverge and collect on the upper and lower plate surfaces respectively, due to a sinusoidal flow path and eventually rise to the surface or gravitate to the bottom of the tank for subsequent collection, while the clean liquid discharges over the outlet weir. Since the separation height is determined by the vertical distance between the plates the capacity of the unit is substantially increased in comparison to traditional gravity separator tanks.

Edible offal and petfood

Summary of problems and solutions

Problems	Points to Consider	Solutions
Excessive water usage	• Control of processing sprays	• Use knee or thigh operated valves
Excessive solids loss	• Solids in effluent stream	• Static wedge wire screen • Mini-DAF system • CPI system

6

Viscera, Tripes, Bibles and Intestines

1. Paunch Dumping

The wet dumping of paunch contents increases water consumption and loads the effluent stream with a high BOD, high nutrient, liquid waste load. Water consumption and effluent loadings are reduced by dry dumping. In a dry dumping system the paunch is opened and the contents emptied into one chute, before rinsing the paunch into a separate chute.

Dry dumping of beef paunches is readily achieved by installing a diversion flap in the bottom of the paunch table collection chamber. After removal of the bible (omasum) and the crown (mesenteric) the paunch is opened above a deep chamber or chute leading to the paunch solids disposal system. The solids are dropped into the disposal system and discharged to a solids pump or pneumatic blow gun. A flap controlled by a pneumatic cylinder is then activated, closing off the solids disposal chamber, and opening a discharge port to the liquid effluent stream. The flap should be activated automatically when the operator turns on the water to wash the empty paunch.

Any liquid residue from paunch dry dumping should if possible be treated with rendering plant effluent in a segregated waste stream and not discharged to the normal effluent treatment system. Dry dumped paunch solids are ideal for composting with other waste materials, or disposal via a worm farming operation. Under some circumstances paunch waste may be spread directly on suitable land.

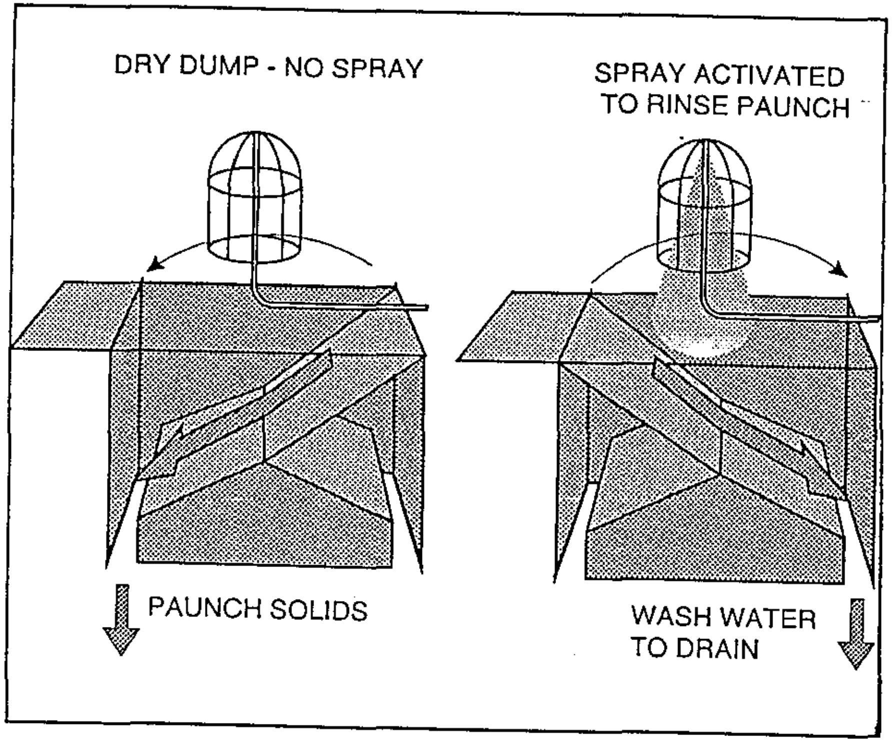

Figure 6.1 Paunch dry-dumping/washing unit.

Dry dumping of sheep paunch is also possible; however due to the generally high throughput, it is not feasible to open the paunch manually. A machine has been developed to dry dump sheep paunch, and this machine is undergoing commercial trials. (Refer Appendix page 92).

2. Soft Offal – Cutting and Washing

Hasher Washers

Old technology disc hasher/washer units result in the loss of substantial quantities of crumb fat to the effluent system. The hasher comprises two contra-rotating shafts running at different speeds. In the standard configuration plain cutter blades are mounted on the high speed shaft and serrated (saw) blades on the slow speed shaft. Shortcomings of hashers include the problem of gut material being torn into strips that entwine in the washer, entrapping gut contents.

- Hasher washers often have a negative influence on tallow quality. Also, excessive fat loss causes blinding of the washer trommel, which in turn requires excessive use of water, including warm or hot water to keep it clear.
- In a variation to the standard configuration, saw blades replace the plain cutters on the high speed shaft. This increases the capacity but results in more crumb fat loss to the effluent system.

Gut Cutters

New technology includes the gut cutter, *(Hamilton & Aust 1989)*, (refer Appendix, page 90) which cuts the soft material with a scissor-like action reducing the amount crumb fat released into the effluent. The cutter can be coupled to a high pressure washer (*Hamilton & Aust 1989*) together with a dewatering screen, e.g. 'Contra-shear' (refer Appendix page 93).

- The washer is installed in the cutter discharge chute and comprises several high pressure spray nozzles mounted on the sides of the chute and directed inwards so that the cut material is effectively washed as it falls.

Immersion Washing

It has been suggested by MIRINZ (Meat Industry Research Institute of New Zealand) that immersion washing results in lower water usage and a reduction in fat loss to the effluent.

3. Recycled Water

Recycled water from the slaughter floor, carcase washing, viscera table and handwash basins, should ideally be used for the washing of all inedible products. This water has only been used for edible product contact, equipment contact or personnel contact and is still of a very high standard. To run it into the effluent system puts an unnecessary hydraulic load on the system and is generally wasteful. This water stream represents a significant proportion of overall plant water usage and its reuse within the plant would be of considerable value. To prevent blockages of nozzles or jets, the water should be screened to remove gross solids before it is reused.

Recycle at Source
Water from:
• Viscera table;
• Carcase washing;
• Hand basins,
should be reused immediately for offal washing

4. Pig Stomach Dry Dumping

A Danish company has developed and marketed the 'Stridhs' hog stomach opener for the dry dumping of pig viscera. (See Appendix page 92). Stomachs are conveyed over a rotating slitting blade and manure falls into a chute.

5. Tripe and Bible Cleaning

Tripe and bible cleaning machines invariably use large volumes of both hot and cold water. The La Parmentiere multi purpose tripe and bible washing-scalding machine is an efficient unit, however its water usage can also be excessive and must be controlled.

La Parmentiere – Hourly water usage			
Model	Capacity	Hot Water (60-65°C)	Cold Water
68	50/60 beef or 1200 small stock	2000 litres	2500 litres
88	80/100	2500 litres	3000 litres

- Flow meters should be installed on both the hot and cold water supply lines to monitor and control water usage.
- The waste water from the tripe/bible cleaning machines should discharge over a screen (preferably wedgewire) before disposal into the effluent system.
  The recovered solids should be transferred to the rendering department with minimum delay.

6. Casings

Casing processing produces a range of slimes, mucosa, serosa, salt and other wastes that add a significant BOD and nutrient load to the effluent. There is a tendency in

some casings departments to leave water running unnecessarily, due to the 'wet' nature of the operation. However, constant running of water in these areas is NOT necessary and steps should be taken to minimise water usage.

- Suitable valves should be fitted and operating practices adjusted to eliminate wastage.
- Good housekeeping is important in reducing both the volume and the overall the impact of these wastes.

A well run casings department will minimise water consumption and nutrient loadings in comparison to a poorly run operation. Further processing such as the recovery and concentration of mucosa for heparin extraction will also reduce the nutrient loading.

Viscera, tripes, bibles and intestines
Summary of problems and solutions

Problems	Points to Consider	Solutions
Paunch material in the effluent stream	• Excessive BOD, solids and nutrient load • Separation of dry dumped solids from washings • Solids transfer • Liquid residue disposal	• Dry dump paunch • Twin chute system to separate solids and washings • Solids pump or blow gun for paunch solids • Liquid residue treated with rendering plant effluent
Excess fat in effluent stream	• Fat and tissue loss during cutting and washing guts • Blinding of washer screen • Temperature of wash water	• Modern gut cutter to replace old hasher • Careful use of water spray to clean screen • Use warm, not hot, water • Immersion washing is a possibility
Wastage of water from constant running slaughter floor facilities	• Water use should be minimised • Relatively clean water may be reusable • Reduce hydraulic load on effluent system	• Reuse clean waste-water from kill floor for inedible offal washing and condemned area initial washdown
Water use in tripe and bible cleaning	• Tripe cleaning machines are big water users	• Monitor water usage • Control process to minimise usage
Effluent loading from casings processing	• Effluent stream should be kept concentrated and contained	• Control process to minimise water use • Recovery of mucosa for heparin extraction

7

Condemned Areas

The number of condemned paunches from good quality cattle is generally small and they can be safely processed without emptying gut contents. The effect on tallow quality and effluent load is minimal. However when a large portion of the kill is cracker cow, a high number of 'condemns' can be expected and it is advisable to dry dump the gut contents prior to rendering.

The decision to dump gut contents will be influenced by the effect on departmental manning levels. Where this can be done with no increase in labour costs, there are generally benefits to be gained from dumping. There is no automatic dumping machine for beef paunches however the sheep unit referred to above has potential to be modified to suit. Some operational changes would be necessary to handle unborn calves if foetal blood is not being recovered.

If condemned paunch material is to be dumped, the preferred method would be dry dumping. Both the solid paunch contents and the washwater should be handled in the same manner as normal paunch material.

> Small numbers of Condemns can be processed, guts intact. However, tallow quality will suffer if large numbers of condemns are processed, guts in.

1. Recycled Water

Recycled water should be used for all washdown purposes in the condemn area, except for final sanitising.

8

Pneumatic Conveying (Blow Tanks)

To minimise the possibility of blockages in the pneumatic conveying system, the addition of water to the material is common. Often this water addition is not regulated or controlled. Sometimes a hose is left running continuously into the screw conveyor feeding the blow tank, so the volume of water in each charge is dependent on the frequency of the blow cycle. It increases during production breaks such as smokos.

Steam consumption is increased by this additional water having to be evaporated from the cooker during dry rendering.

- Elimination of water from the blow charge is impractical because the consequence of blockages (e.g. lost production) outweigh the problems caused by the water used in a properly managed system.
- It is relatively simple to control the volume of water in each blow charge. The required volume will be dependent on the lay out of the pipeline and the product mix. Moist material requires less water than dry material. A small tank mounted directly above the blow tank can dump a measured volume of water into the tank before material is added for each blow cycle. The water plug moves ahead of the material and lubricates the blowpipe to reduce friction.

> Controlled addition of water to blow tanks will lubricate the pipe and prevent blockages.

A system akin to an old-fashioned cistern with a chain pull makes an ideal water tank. The ball float valve controls the volume. The operating lever is connected to the bell valve operating mechanism on top of the blow tank and it dumps the water when the tank lid opens.

1. Raw Material Drainage

The slurry draining from screw conveyors, blow systems and rendering raw material bins, is one of the most highly concentrated sources of BOD, solids and nutrients anywhere on the plant.

- This slurry should not be discharged to the effluent stream. Whilst it is relatively small in volume, it contains a rich mix of nutrients which would add significantly to the BOD and nutrient load in the effluent, putting unnecessary pressure on the treatment system.

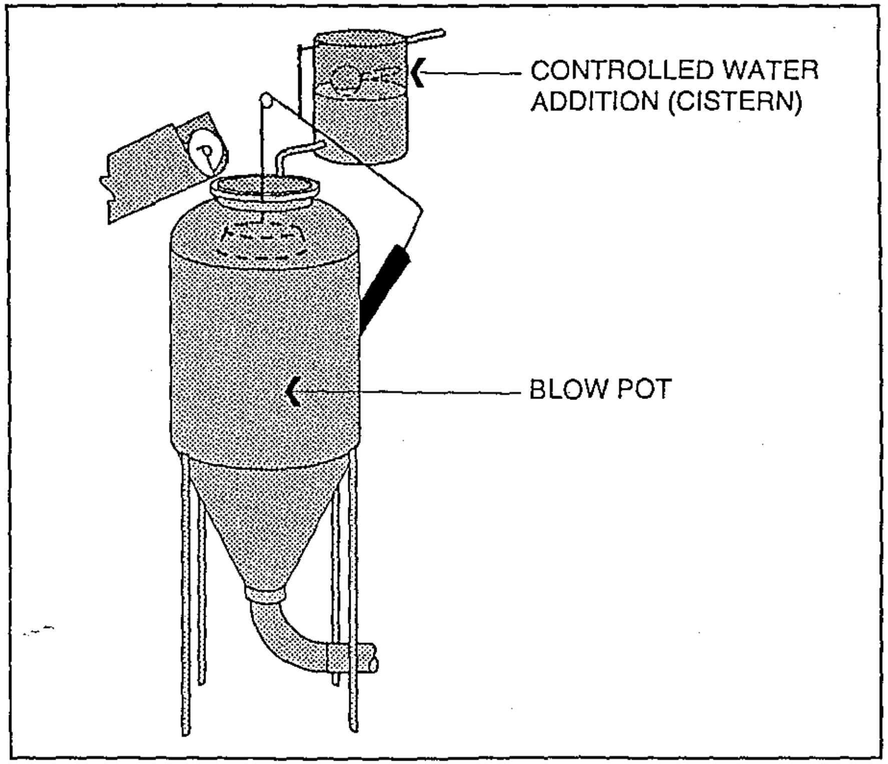

Figure 8.1 Raw material blow system with controlled water addition.

- The amount of slurry should be relatively small if the rendering raw material is handled and transferred effectively. However, even if the slurry contains a high proportion of water, it should nevertheless be collected and processed through the rendering plant and not discharged as effluent. Apart from otherwise representing an undesirable load on the effluent system, the raw material slurry will add to the meat meal protein content.

9

Rendering Plant

Rendering plants do not use a lot of water. Only 10% of the total plant supply is used in rendering. Dry rendering uses water mainly for tallow refining cleandown and steam generating. Wet rendering also requires water for the process, but the quantity is minimal. There is very little opportunity to reduce water consumption in the rendering plant, except in the raw material handling areas already mentioned.

- Of more importance to rendering plant water management, is the fact that approximately 90% of the BOD and nutrient load is generated by rendering.
- Waste water streams from the rendering plant should be kept separated from the lower strength higher volume wastewater stream from the rest of the plant. Wastewater streams are presently not segregated on most plants. However, new environmental standards may mean that it will be more cost effective in the future to treat the high strength stream separately.
  Liquid residue from a paunch dry dumping operation is high in nutrients and should be kept out of the main plant effluent stream. Paunch liquid should be treated with rendering plant wastewater.
- The liquid effluent stream from the rendering plant will comprise condensate from a dry rendering operation, stick water from a wet rendering operation, stick water from a decanter centrifuge, stick water from blood coagulation, and tallow wash water from a polisher centrifuge.

- The drainage liquid from raw material conveying equipment and storage bins should be processed through the rendering plant and not discharged to the wastewater stream.

> High strength effluent stream from the rendering plant includes:
> - Condensate;
> - Stickwater (tallow, blood);
> - Tallow washings;
> - Cleandown water;
> - Paunch liquid.

10

Water Re-use

In the short term, the viability of a water reuse system is based on the initial installation cost and the immediate operating costs of the system. This must be balanced against the availability, purchase and disposal costs of the equivalent volume of fresh water. In the longer term, emerging environmental factors must be considered including the need to preserve groundwater resources and the need to treat effluent to an increasingly high standard.

Once effluent treatment requirements reach the stage where discharge standards are approaching those of potable water, there will be a powerful incentive to take the final step and recycle the effluent.

Regulatory considerations both in Australia and overseas will have to be addressed in respect of recycled potable water. If recycled potable water were to be allowed for sterilising, clean down and other non-product uses, but not for actual product contact use, its contribution to the plant's water use efficiency would still be significant.

> Opportunities exist for full recycle, or at least increased partial recycle.

If the complete recycling of treated wastewater to potable standard and it's subsequent unrestricted reuse were ultimately to be approved, the treatment process would have to incorporate sophisticated methods of removing dissolved solids (i.e. membrane filtration). This would be necessary to avoid a progressive increase in the concentration of salt and other dissolved materials. In the meantime, there are a number of opportunities that exist already where a degree of recycling can be practised.

The first step towards effectively recycling available water will be to segregate the different types of effluent streams.

- Defrost water from freezer stores and blast freezers is non-potable but usually clean. With appropriate filtering it can be reused for evaporative cooling condenser and cooling tower make-up.
- The water from slaughter floor chutes, washbasins, knife and implement sterilisers, viscera table and carcase washing can be reused for gut cutting and washing.
- In non EU registered establishments, water from the final effluent pond can be reused for stockyard washing, hide cleaning and livestock washing if clean potable water is used for the final livestock rinse.
- Aerobic pond discharge water can also be used for watering gardens and trees, irrigation of crops and pastures, subject to compliance with regulatory requirements relating mainly to nutrients and dissolved solids concentrations.

Existing water reuse opportunities:

- Defrost water;
- Steriliser/washbasin water;
- Secondary (pond) treated effluent.

11

Defrosting

The temperature of defrost water for blast freezers and cold stores should be at the lowest temperature that will effectively remove the frost or ice build-up. This will minimise fogging and the resultant build-up of frost on cartons and structures.

- The drain water from the coils can be collected in a storage tank for recycling.
- Steam heating coils can be installed if required, to control the water temperature within acceptable limits.
- Surplus water can be diverted to evaporative condenser or cooling tower make-up as set out in Chapter 10 (page 69).

Hot gas or electric defrost should be considered as alternatives to water defrosting. Hot gas defrosting will impose a cost penalty in terms of the energy requirements of the refrigeration machinery, by increasing the amount of refrigerant to be handled. Sometimes the discharge pressure of the compressors has to be raised to provide sufficient hot gas during periods of low refrigeration demand; thus further increasing costs. Total operating costs should be considered when comparing alternatives.

Electrical defrosting is widely used in commercial applications but it is not so common in industrial installations.

12

Gear Cleaning

Care should be exercised to avoid spills of concentrated acid and alkali formulations. The floor drain outlets in the gear cleaning department should be fitted with plugs to trap any accidental spillage. Spillages should be dry cleaned by mopping up using absorbents, instead of allowing the concentrate to drain into the effluent system.

Management control procedures should monitor chemical usage and ensure that the supervisor responsible for effluent matters is immediately advised of any significant release of the concentrates into the system.

- Ideally the acid and alkali tanks should be emptied during a time when the effluent BOD level is low and flow is high.
- This typically occurs towards the end of the post production clean-up, assuming the rendering plant effluent is treated separately, or that the rendering plant has also shut down and finished cleanup.

13

Boilers and Hot Water Generation

Hotwater generation and boiler operation generally, can use an excessive amount of water unless it is carried out efficiently.

In terms of boiler efficiency and water conservation, condensate return should be maximised.

Excessive feed water make-up (raw water) will result in:

- Additional boiler chemical treatment costs;
- Increased fuel to preheat the extra feedwater;
- Higher water consumption.

1. Steam Traps

Steam trap performance should be monitored regularly to ensure efficient operation. Faulty steam traps should be serviced or replaced. Inoperative steam traps will either blow steam or lockup condensate. The former increases steam consumption due to the loss of flash steam in the feed tank, while the latter reduces the capacity of the system.

2. Boiler Blowdown

The TDS (total dissolved solids) in traditional boilers, having a large water volume, can be effectively controlled by periodic blowdown. Blowdown also removes scale and sludge from the bottom of the boiler. Modern boilers require more frequent, or 'continuous' blow down, i.e. ten seconds every minute, to control the TDS. This reduces fluctuation in the firing rate. Sludge and scale removal will still require the occasional blow down via the bottom blowdown cock.

Continuous blow down enables the use of a collection system that retains boiler water solids. The system evaporates the water using the heat available from the difference in total heat of the boiler water, at for example 8 bar gauge, and that at atmospheric pressure. The solids remain in the blow down vessel, instead of entering the effluent system, and can be disposed of separately.

Spirax Sarco can provide excellent literature on the efficient design and operation of steam systems (refer Appendix, page 95).

3. Cooker Vapour Recovery

Cooking vapours can entrain large pieces of light material that carry over into the condenser. In order to maximise performance, the vapour side of the condenser should be examined regularly and any solids accumulation removed. Vertical shell and tube condensers, such as the GIDE units, are susceptible to blockages by carry-over material and it is advisable to install a coarse strainer in the vapour inlet manifold.

Liquid tallow droplets carried over with the cooker vapours will condense on the cooler surfaces of the heat exchanger and reduce the heat transfer coefficient. Shutting off the condensing water for a few minutes will melt this tallow and restore the condenser performance.

4. Hot Water Generation

Some plants generate more hot water in the rendering heat recovery system than they can use. This often results in an overflowing hot water storage tank and it may encourage inefficiencies in hot water utilisation on the basis that the excess will be discharged to waste anyway. This represents a direct waste of water, quite apart from the waste of energy and it may interfere with the efficiency of the primary effluent treatment system.

- Management should first ensure that the raw material feed to the rendering plant does not contain excess water. As a general rule of thumb for dry rendering systems, the heat recovery condensate should be in the region of 46% to 50% of the raw material intake.
- The temperature of the hot water produced by the heat recovery system should be close to 80°C in order to optimise the volume of hot water generated. Temperatures in excess of 80°C can result in premature scale build up on heat exchanger surfaces resulting in a drop in condenser efficiency.

A low water outlet temperature will produce more hot water for a given quantity of cooking vapour. Assuming an inlet temperature of 20°C, then a 70°C outlet temperature produces an additional 20% hot water and a 60°C outlet temperature an additional 50% hot water, compared with an outlet temperature of 80°C.

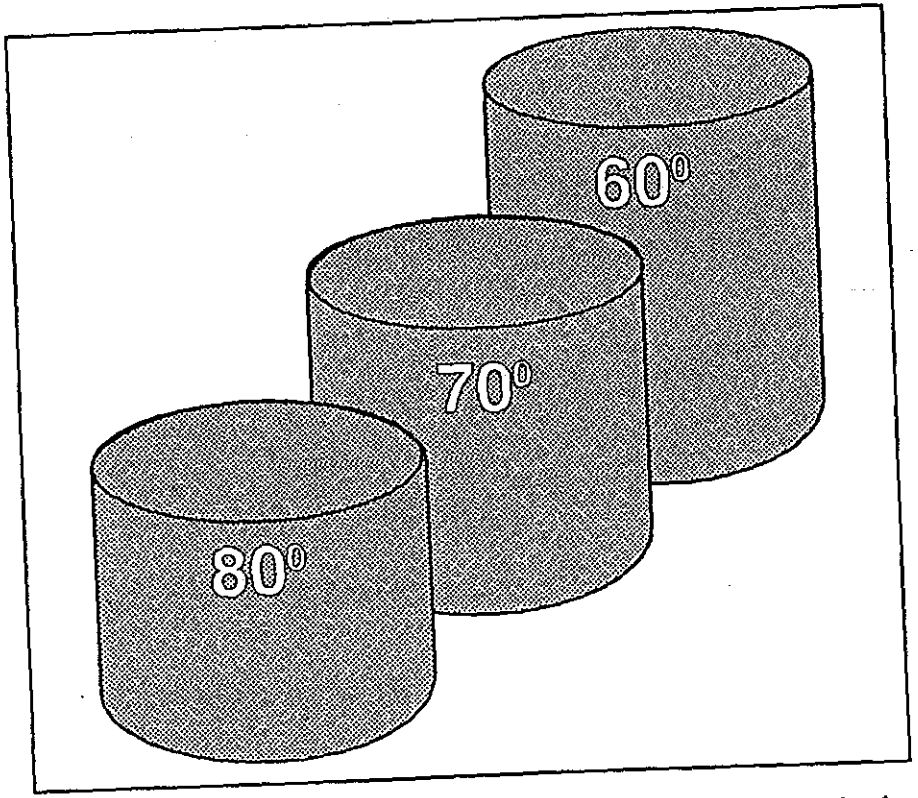

Figure 13.1 Low temperature heat recovery yields excess hot (warm) water and therefore wastage.

Boilers and hot water generation

Summary of problems and solutions

Problems	Points to Consider	Solutions
Steam traps	Inoperative traps will • blow steam, or • lock up condensate	• Service, or replace faulty traps
Boiler blowdown	• Control or TDS • Removal of scale and sludge • Control of fluctuating firing rate • Retention of blowdown solids	• Continuous blowdown
Cooker vapour recovery	• Carryover of tissue which blocks condenser • Liquid tallow droplets carryover reduces heat transfer	• Regular inspection of condenser • Coarse strainer in vapour outlet • Shut off condenser water. Tallow melts and performance is restored
Hot water generation	• Generation of excessive hot water • Prevent scale build-up on heat exchanger surfaces	• Minimise excess water in raw material • Generate hot water recovery at close to 80°C • Avoid hot water recovery at >80°C.

14

Amenities and Administration

An area often neglected when consideration is given to possible opportunities to reduce water usage is the amenities and general administration facilities on the plant. When ablution facilities are used by everyone on the plant, a significant amount of water is necessary to service them. Opportunities for improved usage efficiency therefore do exist.

- To minimise water consumption, the use of dual capacity toilet flush systems are now mandatory for new installations and replacement cisterns in some states.
- Constant fill cisterns for flushing of urinals are no longer allowed. These operate continuously at weekends and overnight even when not in use. A low fill rate of 1.5 litre per minute is equivalent to 769 kL per annum for each unit.
- Demand flushing of urinals is a viable alternative because the mechanism only operates when activated, either by photoelectric sensors or limit switches interlocked with a 10 or 20 minute timer. Water release is triggered by the timer. In the latter system a spring loaded grille mounted above the urinal is depressed when someone steps onto it, this action closes a N/O (normally open) contact on the limit switch and initiates the timer.
- Odours can be a problem during long periods between use and a second timer set at say two hours can be incorporated into the circuit to provide periodic flushing if necessary.
- Manual adjustment of the water temperature for washbasins and showers can result in wastage if

the water is allowed to run until the temperature stabilises before use. There is also the potential safety hazard of someone being scalded in a multiple outlet facility because adjustment of the flow rate at one outlet affects the others. Installation of thermostatic mixing valves will automatically adjust the outlet temperature of the water and overcome both problems (see Appendix page 95). The units should be sized to suit each application, i.e. the number of outlets being served by the individual mixer. As a rule, allow 7.0 litre per minute for each shower rose.

- Water saving shower roses are readily available however some models that reduce water flow are not very effective and may result in the rose being removed or vandalised. Installation of a flow regulator in the supply upstream of the outlet may discourage tampering. Shower roses should be selected for both optimal water use and user satisfaction. It may be necessary to experiment with different models in order to decide on an optimum unit.
- In a work environment, the hot water calorifier pumps serving the amenities have to cope with a wide range of flow rates ranging from zero to maximum flow. The pumping system must provide the required pressure during peak periods and this may result in excess pressure when consumption is low. This situation can be avoided by controlling pump capacity to match demand. Constant pressure should be provided via an inverter drive (frequency controller) to automatically adjust the pump speed in a single pump installation. In a multiple pump installation the base pump provides the required capacity during non-peak periods with the other pump(s) operating as required via a suitable time clock and pressure switch combination.

15

Cleaning Generally

The cleaning operation can have a significant effect on overall plant water usage. Cleaning practices need to be carefully defined and cleaning workers should have ready access to the procedures and instructions.

Equipment and fittings can also have a significant effect on water usage in relation to cleaning operations. Facilities should be properly designed for the purpose and they should be maintained as necessary to avoid unnecessary water usage.

Suitable equipment, as well as suitable chemicals should be used in the cleaning process (refer Appendix page 92 and 96).

- Floor waste outlets should be designed to minimise blockages caused by solids covering the grates during washdown. Convex grates can be installed that allow the water to flow over the top of accumulated solids. Grates should be locked or fixed in place to prevent unauthorised removal by the cleaners. Existing state of the art floor waste and drainage systems include grates designed for most applications (refer Appendix page 96). Although not necessarily cheap compared with conventional systems, the lightweight construction and design of modern systems simplifies installation and is adaptable to existing pipeline materials.
- Documented cleaning procedures for each department should be made available to cleaning personnel. The documents should be illustrated to enhance comprehension, laminated (waterproofed) and reviewed regularly to ensure continued effectiveness, economy and

compliance with current regulatory requirements.

- Collect all gross solids by dry cleaning before water is applied. Water consumption is reduced and the efficiency of the cleaning procedures will be improved.
- Reduce the wear and tear on floor surfaces and improve hygiene by using nylon brooms and plastic shovels.
- Separate out non-meat items such as polythene, cartons, strapping, and cleaning materials, such as *Scotchbrite* pads and disposable gloves, for removal from the premises along with similar solid wastes.
- Transfer meat solids (meat waste, fat and coagulated blood) to the rendering department promptly to reduce bacteriological degradation.

Cleaning procedures from this point on depend on the regimes that have been adopted by the plant and the amount of fat and/or blood adhering to floors, platforms and working tables.

- Areas that have high levels of fat residues, such as boning and cutting rooms, require high pressure low volume water at approximately 60°C to give the most economical water usage. This will remove gross solids to a degree where foam cleaning can be effective. Higher water temperatures will increase the amount of steam vapour, and associated condensation problems, without any increase in cleaning efficiency.
- Care is necessary to avoid the transfer of soilage via the high pressure water stream, to relatively clean surfaces such as walls and ceilings and to avoid damage to the building fabric.
- Cleaning chemicals and procedures should be selected on the basis of their compatibility with the equipment, materials and building fabric, including electrical fittings, in order to avoid excessive replacement or maintenance costs. Written verification should be sought from chemical suppliers, to the effect that their products comply with the specified criteria.

- Usage of detergents and foam chemicals should be monitored on a departmental basis as a means of monitoring cleaning efficiency.
- Sanitisers should be applied as a fine spray to cleaned surfaces, in lieu of final rinsing with 82.2°C water if possible. Chemical sanitisers can be more effective in bacteriological control, less damaging to the building fabric and safer for personnel, than large quantities of hot water.

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Appendix 1

Suppliers Index

This index includes details of equipment referred to in this manual and the associated equipment suppliers. Details may include a general explanation of the equipment together with some information on specifications and cost. Cost figures are indicative only (early 1995).

The equipment is presented in an alphabetical listing according to the term used to describe the piece of equipment in each case.

References to the Suppliers Index are included throughout relevant sections of the text.

A separate index listing (beginning on page 105) includes details of suppliers' addresses and contact numbers.

Item/Make	Supplier/Details

Chute Cleaners

Indclean — Spray Nozzle Engineering P/L

A range of three nozzles covering chute diameters between 200 and 700 mm is claimed to be effective when powered by the Lato 'Commanche' H.P. water cleaner.

CIP & Tank Washers

Moog container cleaner — Spray Nozzle Engineering P/L

Portable robotic cleaner for internal cleaning of tanks and other containers. Rotary head is powered by any high pressure pump.

WP:	250 bar
Flow rate:	80.0 L/min
Working temperature:	150°C

'M' series tank washers — Spray Nozzle Engineering P/L

Self operating cleaner for large storage tanks and drums. Minimum misting at a wide range of operating pressures with self-cleaning head.

Model M-30 Keg washer

WP:	1.5 – 4.0 bar
Flow rate:	43.5 – 75 L/min
Working temperature:	<120°C

Model M-50 & M-75 Tank washers

WP:	1.5 – 4.0 bar
Flow rate:	63.5 – 312 L/min
Working temperature:	<120°C
Tank capacities:	90,000 – 240,000 litre

Prosser rotating heads — Spray Nozzle Engineering P/L

Tank and drum cleaning heads suitable for CIP applications.

WP:	2.8 – 12.7 bar
Flow rate:	38 – 266 L/min
Working temperature:	<122°C
Effective cleaning radius:	1.81 – 3.63 m

Item/Make	Supplier/Details

Corrugated Plate Interceptors

Facet — King & Sons P/L

The Facet CPS, or coalescing plate separator, system is an upgraded version of the standard CPI unit and can be designed to handle flow rates between 7 and 6850 L/min. Small droplets are coalesced into larger droplets of 20 micron or larger which increases the rate at which the lighter phase will rise to the surface, therefore smaller plate modules are required for similar outputs.

Flow Restrictors

Self regulating

RMC — RMC Valves

Regular flow rate achieved over a wide range of inlet pressures, from a low of 0.5 bar to a high of 14 bar. Simple and economical design suitable for shower heads and taps. Standard flow rates are: 3.4 – 6 – 8 – 10 – 12 and 16 L/min.

Model No M&F 50 inlet 1/2" BSPM outlet 1/2" BSPF.

Price approximately $17.00 – $18.00.

Metering plates

Spraying Systems Co. — Spraying Systems Australia P/L

In-line discs to suit Unijet nozzles. Capacity range from 0.03 – 26 L/min @ 2 bar.

Delavan — Spray Nozzle Engineering P/L

Type 1505 metering orifices to suit nozzle assemblies and type RO restrictor orifices for pipe line installations, 1/4" – 1" BSPM threads. Capacities range from 0.026 – 23 L/min @ 2 bar.

Item/Make	Supplier/Details

Gut Cutters

Brentwood shredder — Shred Tech P/L

Several sizes of prebreaker units available.

Units separately available for hard offal prebreaker and soft offal cutter.

MIRINZ cutter — Unit available for soft offal cutter.

Hand Basin Components

Manually Operated Valves

MIRA — LW Gemmell & Associates

MIRA TF750 knee operated flow control valves with timed shut-off after approximately 15 seconds.

WP:	7.0 bar
Flow rate:	4 to 10 L/min
Working temperature:	70°C
Price:	$325.00 nett excl. tax

T & S — LW Gemmell & Associates

T & S foot operated valves, single or dual pedal with either wall or floor mounting.

Autotap — Northan Distributors P/L

The Northan 'Autotap' knee operated valve has a fibreglass actuating rod and water flow is cut-off 9 seconds after the rod is released. The assembly including two stop valves costs approximately $432.00

The 'Autotap' foot operated model can also be mounted for knee operation. The unit complete with stop valves is priced at approximately $288.00

Item/Make	Supplier/Details

Infra-Red (IR) Actuators

Autotap — Northan Distributors P/L

The IR sensor is installed at the base of the gooseneck and water flow is automatically shut-off when the IR beam is restored in the 'Autotap' unit. Pilot operation of the solenoid valve closes the valve slowly to avoid water hammer.

The installation kit includes the IR sensor, 24 volt power supply, solenoid valve, two stop valves and cabling.

Cost is approximately: $460.00.

CF & T — LW Gemmell & Associates

Model LS801 auto tap with integral solenoid valve and infra-red sensor built into the body of the tap. Water flow stops immediately when the hands are withdrawn from the sensing zone, there is also an automatic cut-out after about one minute if something is deliberately placed in front of the IR sensor.

In its present form the tap is not adaptable to the gooseneck outlets generally fitted to amenities basins.

Operating voltage:	12 VDC
WP:	0.5 to 7.5 bar
Price:	$355.00 nett excl. tax

The model S101 Sensatap comprises three separate components, solenoid, sensor and transformer, providing flexibility of installation. The IR sensor has a range of 140 mm and the solenoid valve opening time is adjustable between eight seconds and six minutes. It will shut-off water flow if the IR beam is permanently broken making the S101 suitable for amenities basin installations.

Operating voltage:	24 VAC
WP:	10.34 bar
Price:	$355.00 nett excl. tax

Item/Make	Supplier/Details
Optical sensors	Erwin Sick Optic-Electronic P/L
	A wide range of optical sensors adaptable to many control applications.

Paunch Opening Machines (Small stock)

(CSIRO development)

An automatic conveyorised machine for the opening of sheep paunches to dry dump the contents prior to washing. It incorporates automatic feeding of the paunches into the machine.

This machine is undergoing commercial trials.

Stridhs	AB Stridhs Maskiner
	Developed for the mechanised opening and emptying of pig stomachs. An operator manually impales the stomachs onto the guide bar which carries them into the machine enclosure, after emptying they are ejected down the discharge chute.

Plumbing & Drainage Systems

Blücher	Blücher (Australia) P/L
	A range of lightweight stainless steel plumbing and drainage fittings up to 160 mm nominal diameter with push-fit assembly requiring no special tools or welding during installation. A variety of drain grates and removable baskets are available to suit individual applications, either with or without water traps as required. The fittings can be supplied as a total system or individually, a range of adaptors to connect to other pipe materials is available.

Pressure Water Cleaners

Portable	Lato Industries P/L
	A range of electric and petrol powered portable high pressure water cleaners with capacities between 8 – 30 L/min and pressures of 100 – 200 bar. Suitable for connection to various cleaning heads, the

Item/Make	Supplier/Details
	'Commanche' unit at 21 L/min and 200 bar coupled to 'Indclean' rotary pipe cleaning nozzles will clean product chutes between 200 and 700 mm diameter.
Gerni	Viking Powerclean P/L
	The Gerni range of electric powered high pressure water cleaners have stated capacities between 7.5 and 28 L/min and nozzle pressures from 155 to 260 bar. These pressures are based on the Gerni Turbo Laser water jet which delivers larger droplets with higher impact than standard nozzles.
	The Gerni units can be used as portable stand-alone cleaners or connected to a centralised departmental system. Up to three units can be installed in a parallel, 'triple link', system with individual cleaners being automatically switched on and off, on demand, via pressure switches.
	The model 208, 310, 480 and 880 units operate at an inlet water temperature of 60°C while the model 660 has a maximum inlet temperature of 80°C. Higher outlet temperatures from 90 to 130°C are available in the 3000 and 4000 range when connected to an external steam supply.

Screening Units

Rotary

Contrashear	Contra-Shear Technology
	Rotating wedge wire trommel screen, water introduced to the screen over a weir box inside the trommel.
	The 600, 900 and 1500 Series with a 0.75 mm screen gap have rated capacities:
	363 L/min for the 6/6 model, through to:
	9,874 L/min for the 15/30 model, when treating paunch and stockyard wastes. These increase to:
	366 L/min and 11,123 L/min respectively with a gap of 1.0 mm.

Item/Make	Supplier/Details
Rotostrainer	Rotating wedge wire screen with water passing through the screen from the outside to the inside (dewatering time is limited).

Static

Wedge wire

Item/Make	Supplier/Details
Bixby-Zimmer	CMI Services P/L Custom designed screens manufactured under licence using the 'Bee-Zee' range of screen rods. They includes flat deck, inclined and rotary screening units.
Dorr-Oliver	Dorr-Oliver P/L The parabolic contour of the screen effectively removes solids approximately half the size of the opening between the wedge wire bars. The initial segment of the screen is near vertical and this presents a reduced opening to the solids as they gravitate down the screen while the water passes through the bars. The solids progressively concentrate as they move to the lower sections of the screen. The water content may be relatively low at the discharge point.
Bauer Hydrasieve	Similar to the static screen described above.

Spray Nozzles

Item/Make	Supplier/Details
Spraying Systems Co.	Spraying Systems Australia P/L
Delavan	Spray Nozzle Engineering P/L
Prosser	"
Polyscreen	"
Silvent Blowing (pneumatic)	"

Steam & Water Mixing Stations

Item/Make	Supplier/Details
Sellers jet	Spray Nozzle Engineering P/L
Spirax Sarco	Spirax Sarco P/L Australia
Strahman	Spray Nozzle Engineering P/L
T & S Dynafluid	LW Gemmell & Associates

Thermostatic Water Mixers

Grohe — Argent Australia P/L

The Grohe thermostatic mixing valves, TMV, are available in two sizes, 15 and 20 mm, with either recessed or wall mounting. A 'failsafe' protection feature stops the water flow if either the hot or cold supply is interrupted. Each TMV has built-in stop valves, strainers and non-return valves. The temperature control mechanism is protected against tampering.

Supply pressure:		0.5 to 10 bar	
Operating pressure:		1.0 to 5 bar	
Maximum outlet temperature: 80°C			
Minimum flow rate:		15 mm	5 L/min
		20 mm	5.8 L/min
Capacities:	15 mm	13.0 L/min @ 0.5 bar	
		45.0 L/min @ 6.0 bar	
	20 mm	20.0 L/min @ 0.5 bar	
		68.0 L/min @ 6.0 bar	
Price:	15 mm	$ 325	
	20 mm	$ 425	

Tour & Andersson — BEP

Two sizes are available in the TA-mix valves, 15 and 20 mm, with capacities of 30 and 36 L/min. The water temperature control knob is not protected against tampering and alternative security is required for industrial applications.

WP:	<10.35 bar
Temperature range:	35 to 65°C
Prices:	$80 to $90 c/w adaptors

Item/Make	Supplier/Details
Methven	LW Gemmell & Associates Flow rate: 20 L/min @ 0.35 bar Working temperature: >35°C

Vacuum Cleaners

Item/Make	Supplier/Details
Gerni	Viking Powerclean P/L A range of wet and dry portable industrial vacuum cleaners with tank capacities up to 58 litres and suction power to 2400 mm vac. The VAC 2000 WD model is currently being used in boning room applications.
Portaboom	Viking Powerclean P/L A recent innovation is the 'PORTABOOM' concept, developed in the USA, for containing spillage or contaminated run-off. The system includes a pick-up or suction boom and a wet and dry recovery unit. The boom consists of a flexible D shaped foam tube, lying on its 'back', which has a series of inlet ports along the lower inside edge. The suction developed by the wet and dry unit holds the boom to the ground, even over ridges and indentations, and contains the water inside the boom until it is picked up. The liquid can be pumped direct to the effluent system for disposal or into a tank or drum for product recovery. The boom comes in 1.5 m modules and is fitted with quick coupler connectors. The 'Portaboom' total pac kage costs about $6000.00 and has numerous applications in the meat industry where polluted hard standing areas drain into the storm water system.

Water Flow-Meters

Flowmeters come in a variety of types and operating principles including: positive displacement; vortex; turbine; magnetic and ultrasonic. The wide range of flowmeter type, price and accuracy provides for meter selection to be tailored to suit individual applications.

Item/Make	Supplier/Details
Positive displacement	Accuracy ± 0.5 to 2 % The most common types available include rotary piston and gear models.
Vortex	Accuracy ± 1 % The vortex shedding meter has an obstruction in the flow path and vortices form behind it. This shedding is nearly proportional to flow rate and reasonable accuracy of measurement is achieved.
Turbine, Helical and Jet	Accuracy ± 1.5 to 2 % This group is among the most economically priced water meters available. The rotor element is inserted into the fluid flow and rotation of the impellor is transmitted to the register via a direct drive, magnetic coupling or pulse output.
Magnetic	Accuracy ± 0.25 % Microprocessor based electromagnetic flowmeters consist of a metering tube and transmitter. In addition to a local register providing both rate of flow and totaliser functions, the transmitter normally provides a mA output for interfacing with chart recorders, dataloggers or computers. The fluid to be measured must have a minimum electrical conductivity dependant on the design characteristics of the unit.
Ultrasonic	Accuracy ± 1.0 to 5 % Ultrasonic or transit time flowmeter accuracy is dependent upon the type of flow cell or transducer used in pipeline applications. Wetted transducers, in contact with the fluid, are the most accurate but the clamp-on transducers provide more flexibility, especially for survey type applications. Ultrasonic flowmetering is also used for open channel metering in conjunction with a flume or weir. The transducer is mounted above the surface of the liquid and measures variations in the distance between the transducer and liquid surface level.

Item/Make	Supplier/Details

Magnetic flowmeters

Hersey — Macnaught Industries

The Hersey balanced electrode plane (BEP) electromagnetic flowmeters claim to have higher accuracy than comparable units. The BEP principle eliminates the requirement for electrical ground or earth rings and avoids the errors caused by electrical noise.

Stated accuracy is ± 0.25 % of flow rate.

Four sizes are available, from 1" through to 4", covering flow ranges between 1.5 to 170 and 30 to 3800 L/min.

WP:	19 bar @ 38°C
	13 bar @ 177°C
Fluid temperature:	-26 to 177°C
Fluid electrical conductivity:	≥ 3 hS/cm

A 1" imported unit costs ca $2,000. Should be manufactured locally from 1995.

Danfoss — Danfoss (Australia) P/L

The Magflo electromagnetic flowmeters type MAG 1100/3000 also have a stated accuracy of ± 0.25 % of flow rate but the minimum electrical conductivity of the fluid is 5 hS/cm.

Six sizes are available ranging from 15 to 100 mm. The manufacturer recommends a fluid velocity of 1 to 2 m/sec for non-viscous fluids. The flow ranges are as follows:

15 mm model – from 10 to 20 L/min,
100 mm model – from 450 to 900 L/min

WP:		40 bar
Fluid temperature:		-20 to 200°C
Price:	50 mm	$2,400
	80 mm	$2,600
	100 mm	$2,900

Item/Make	Supplier/Details

Positive type

Davies-Kent — Davies Shepherd P/L

Type KG positive water meters are available in sizes 25 to 80 mm. Effective flow capacities range from:

0.5 to 63 L/min for the 25 mm size, to:
4.5 to 400 L/min for the 80 mm size.
Accuracy at the design capacity is ± 2%.

WP:	<14.5 bar
Working temperature:	<50°C

Price:	50 mm	$870
	80 mm	$1,655
	100 mm	$2,465

Oval — Macnaught Industries

The Oval positive displacement range of meters includes the locally manufactured M10 and M40 series. Accuracy is claimed to be ± 0.5 % of the reading. Mechanical and LCD registers are available or alternatively a pulse output version is suitable for interfacing with a data logger or computer. The LCD register combines flow rate and totaliser displays.

Flow rate:	M10	8 to 85 L/min
	M40	20 to 200 L/min
Working temperature:		<80°C
	M40 option:	120°C
Materials:	Aluminium body and cap – standard, Type 316 stainless steel – option.	
Price:	M40 316 SS unit with LCD register and pulse output is approximately $2,000 ex works.	

Item/Make	Supplier/Details
Turbine meters	
RMC	Reliance Manufacturing Company
Multijet	The Multijet meter is designed for domestic applications:
	15 mm and 20 mm sizes with capacities of 25 and 42 L/min.
	With operating temperatures to 50°C and pressures to 16 bar, they are also suitable for industrial installation.
	The turbine rotor is directly connected to the mechanical register which has readings in kL. Claimed accuracy is ± 2 %.
	Cost: Between \$97 and \$103
Econo-meter	The RMC econo-meter range is available in six sizes:
	50 to 200 mm, with capacities covering 50 to 8333 L/min.
	Mechanical registers with readings in m³ are standard. Pulse outputs as an optional extra. Accuracy is ± 2 %. Standard meters are rated at 50°C. Hot water versions are available with continuous rating to 90°C and occasional temperature to 120°C.

WP:	16 bar	
Flow rate:	50 mm	50 to 500 L/min
	80 mm	133 to 1,333 L/min
	150 mm	500 to 5,000 L/min
Price:	50 mm	\$730 mechanical
		\$917 pulse
	80 mm	\$894 mechanical
		\$1,057 pulse
	150 mm	\$1,417 mechanical
		\$1,717 pulse
	50 mm HW	\$917
	80 mm HW	\$1,084

Item/Make	Supplier/Details
Irrigation	The Irrigation meters come in six sizes:
	65 to 200 mm with capacities from 133 to 15,000 L/min.
	Claimed accuracy is ± 2 %. The dial registers in kL, although pulse output models are available. The turbine rotor is mounted in a 'water wheel' configuration to prevent the meter being choked by solids.

WP:	16 bar	
Price:	65 mm	\$679 mechanical
		\$919 pulse
	80 mm	\$747 mechanical
		\$980 pulse
	150 mm	\$1,337 mechanical
		\$1,634 pulse

Item/Make	Supplier/Details
GPI	Macnaught Industries
	The GPI electronic digital turbine meters are battery powered and three models are available in 1" and 2" NTP sizes. The digital register displays either flow or total rates.
	Accuracy is ± 1.5 % for non viscous liquids. All models are rated at 60°C.

Flow rate:	1 to 10 L/min	1" NTP
	10 to 190 L/min	1" NTP
	100 to 1000 L/min	2" NTP
PD at max flow:	0.14 bar	1" models
	0.48 bar	2" models
Price:	1" nylon body	\$220
	SS body	\$1,500

Item/Make	Supplier/Details

Helix

Davies Shephard P/L

The Helix 3000 helical vane type range of meters with sizes between 40 and 150 mm have recommended continuous flow capacities from 600 to 7,583 L/min. Accuracy at the above flow rates is ± 2 % and the meters have a maximum operating temperature of 50°C. Optional features on this range of meters include the Kent pulse unit and the Kent remote totaliser.

Standard meter costs:		
	50 mm	$632
	80 mm	$705
	100 mm	$915
	150 mm	$1,257

Pulse outputs, additional cost per meter:

Units with one pulse per 10.0 L:	$144
Units with one pulse per 1.0 L:	$177

Hydrometer

Davies Shephard P/L

This range of M-TX domestic water meters are available in sizes 15 to 50 mm with capacities from 25 to 250 L/min.

Larger capacities from the 80 and 100 mm model W-SX meters.

Pulse outputs and hot water versions, to 120°C, are available in both the M-TX and W-SX models.

Relative prices for 120°C hot water service units are:

	No pulse output	Pulse output
20 mm	$104	$291
25 mm	$314	$560
40 mm	$506	$642
50 mm	$812	$848
80 mm	$1,205	$1,357
100 mm	$1,630	$1,785

The KSS and AROS models also cover sizes from 20 to 100 mm but are rated for a maximum of 90°C. Comparative prices start from $55 for the 20 mm model, no pulse output and $79 with pulse output, through to the 100 mm model, no pulse output, at $1,115.

Item/Make	Supplier/Details

Meinecke

Macnaught Industries

The Meinecke COSMOS-T meters have hermetically sealed registers and pulse output options are available. Five sizes in the 50 to 125 mm range share common measuring mechanisms and parts are interchangeable.

Capacities range from 16.6 to 667 L/min for the 50 mm unit and 66.7 to 3,333 L/min for the 125 mm unit. Additional models up to 500 mm diameter and 50,000 L/min capacity are also available.

WP:	16 bar
Fluid temperature:	50°C

Price:		
	50 mm with pulse output	$800
	80 mm with pulse output	$1,000

Ultrasonic flowmeters

Panametrics

Panametrics P/L

The Panametrics model 6068 and 6468 transit-time ultrasonic flowmeters are designed around a 32-bit microprocessor. Fluid velocity, flow rate or totalised outputs are available. Wetted or clamp-on (2") transducers, covering pipe sizes from 1/8" to 80" diameter, are available. Claimed accuracy is ± 1% for wetted and ± 1-5% for clamp-on transducers.

The model 6068 provides continuous flow measurement from one point and the model 6468, continuous multiplexed flow measurement for up to four points.

WP:	206 bar
Fluid temperature:	-200 to +260°C

Price:		
	model 6068	$8,000
	model 6468	$20,000 for four points

Item/Make	Supplier/Details
Sonoflo	Danfoss (Australia) P/L The Sonoflo flowmeter operates on the 'transit time' principle and requires the pipe to be full of liquid, i.e. no voids. Claimed accuracy is ± 1% of measured flow. The transducers can be retrofitted to existing pipelines by special mounting kits and do not intrude into the liquid flow path. Two model ranges are available, with ten sizes between 10 and 100 mm and 12 sizes from 100 to 800 mm diameter. The maximum flow velocities for the various sizes are: 10 – 25 mm: 2.5 m/sec 32 – 80 mm: 5.0 m/sec 100 mm: 10.0 m/sec WP: 40 bar Fluid temperature: -20 to 100°C Price: 25 mm $2,200 300 mm $5,600
EMUC	Danfoss (Australia) P/L The EMUC ultrasonic unit is designed for open channel measurement. The transducer can be mounted a maximum of 3.9 metres above the fluid surface level. Typical applications include effluent discharge to municipal sewers or pondage systems. The standard unit costs around $3,400.

Appendix 2

Supplier / Distributor Contact Details

This index includes the addresses and contact details of the suppliers listed in the Suppliers Index and referenced throughout this Manual.

From mid 1995 onwards, telephone numbers in Australia will have an additional digit. This extra digit should be added to the front of the numbers in this Index. The additional digit and change-over date for the capital cities are as follows:

NSW	Sydney	July 1996	9
Vic	Melbourne	June 1995	9
Qld	Brisbane	July 1995	3
NT	Darwin	May 1996	89
SA	Adelaide	Aug 1996	8
WA	Perth	Sept 1997	9
Tas	Hobart	Nov 1996	62

Supplier	Distributors
Argent Australia	Argent Australia P/L
NSW & ACT:	19 – 25 Wyndham Street, Alexandria, NSW 2015 Ph (02) 319 4233 Fx (02) 319 4303
Qld & NT:	4 Wandoo Street, Fortitude Valley, 4006 Ph (07) 252 5198 Fx (07) 252 2599

Supplier		Distributors
BEP		Bestobel Engineering Products
	NSW:	Units 12 & 13 Centre West, 108 Silverwater Road, Silverwater, 2141 Ph (02) 647 3700 Fx (02) 748 3021
	Newcastle:	Ph (049) 611 121 Fx (049) 621 315
	Wollongong:	Ph (042) 284 600 Fx (042) 289 738
	Wagga:	Ph (069) 251 461 Fx (069) 254 837
	ACT:	Unit 5, 164 Gladstone Street, Fyshwick, 2609 Ph (062) 806 591 Fx (062) 391 346
	Vic:	9 – 10 Bastow Place, Mulgrave, 3170 Ph (03) 561 7000 Fx (030 562 1322
	Morwell:	Ph (051) 345 322 Fx (051) 343 040
	Geelong:	Ph (052) 785 222 Fx (052) 781 462
	Qld:	123 Boundary Street, West End, 4101 Ph (07)844 1711 Fx (07) 844 8878
	Gladstone:	Ph (079) 723 744 Fx (079) 723 200
	Townsville:	Ph (077) 722 599 Fx (077) 723 925
	Mackay:	Ph (079) 573 038 Fx (079) 512 281
	Cairns:	Ph (070) 512 698 Fx (070) 516 960
	SA:	1027 Port Road, Atherton 5014 Ph (08) 472 622 Fx (08) 341 1360
	NT:	Unit 4, Cousins Street, Winnellie, 5789 Ph (089) 843 363 Fx (089) 471 257
	Tas:	412 Brooker Highway, Derwent Park, 7009 Ph (002) 724 744 Fx (002) 728 523
	Launceston:	Ph (003) 265 955 Fx (003) 265 984
	Devonport:	Ph (004) 244 711 Fx (004) 248 911
	WA:	20 Hines Road, O'Connor, 6163 Ph (09) 337 4411 Fx .(09) 331 2774

Supplier		Distributors
Blücher		Blücher (Australia) P/L
	SA:	Bennet Avenue, Melrose Park, SA 5039 Ph (08) 374 3426 Fx (08) 374 3428
	Qld:	Allwater Agencies contact; Lyle Maybury 240, Fernvale, Qld, 4306 Ph (074) 26 7201 Fx (074) 26 7295
CF & T		CF & T Washroom Equipment P/L
	Qld:	PO Box 581, Mermaid Beach, 4218 Ph (075) 78 5199 Fx (075) 78 5260
	Other:	LW Gemmell & Associates P/L refer individual listing for LW Gemmell
Services		Chemical, Mining & Industrial Services P/L
		Telford Street, Virginia, Qld, 4034 Ph (07) 265 2558 Fx (07) 265 2558
Contrashear		Contra-shear Developments Ltd
	NZ:	33 Ruskin Street, Parnell, Auckland Ph +63 (9) 795 192
	NSW:	Contra-Shear Technology Houghton Street, Linley Point,2066 Ph (02) 427 1279 Fx (02) 427 3354
Danfoss		Danfoss (Australia) P/L
	Vic:	1 Ricketts Road, Mount Waverley, 3149 Ph (03) 543 1033 Fx (03) 543 4027
	NSW:	199 Parramatta Road, Auburn, 2144 Ph (02) 648 4982 Fx (02) 748 0573
	Qld:	32 Billabong Street, Stafford, 4053 Ph (07) 356 7911 Fx (07) 352 5052
	WA:	52A Fairbrother Street, Belmont, 6104 Ph (09) 478 1566 Fx (09) 277 8457
	SA:	58 Richmond Road, Keswick, 5036 Ph (08) 371 0422 Fx (08) 371 0907

Supplier	Distributors
Davies Shephard / Kent	Davies Shephard P/L
Vic:	15 Dunstans Court, Keon Park, 3073 Ph (03) 460 3744
Qld:	12 Holland Street, Northgate, 4013 Ph (07) 266 7733 Fx (07) 266 7695
WA:	Belgravia Street, Belmont, 6104 Ph (09) 478 2772
NSW:	Davies-Kent (NSW) P/L Box Road, Caringbah, 2229 Ph (02) 524 0251
SA:	Dobbie Dico Meter Co P/L Ph (08) 51 9891
Dorr-Oliver	Dorr-Oliver P/L
NSW:	28 Spring Street, Chatswood, 2067 Ph (02) 412 1800 Fx (02) 412 1860
WA:	Suite 8, 117 Broadway, Nedlands, 6009 Ph (09) 386 8972 Fx (09) 388 2433
Erwin Sick Optic-Electronic	Erwin Sick Optic-Electronic P/L
Vic:	899 Heidelberg Road, Ivanhoe, 3079 Ph (03) 497 4100 Fx (03) 497 1187
NSW:	10/71 Asquith Street, Auburn, 2144 Ph (02) 748 2111 Fx (02) 748 0801
Distributors:	
Qld:	Ph (07) 849 5077
WA:	Ph (09) 470 4401
SA:	Ph (08) 238 5000
Tas:	Ph (002) 342 233 (003) 316 533
Newcastle:	Ph (049) 525 200

Supplier	Distributors
Gemmell	LW Gemmell & Associates P/L
Vic:	38 Dougharty Road, West Heidelberg, 3081 Ph (03) 459 4411 Fx (03) 459 7485
SA:	Clarrie Scrutton Unit 1/34 Light Terrace, Thebarton, 5031 Ph (08) 234 1801 Fx (08) 352 6711
NSW:	Paul J Duff Plumbing Agencies Unit 58/4 Hoyle Avenue, Castle Hill, 2154 Ph (02) 894 6667 Fx (02) 894 6646
	HG Thornthwaite Victoria Avenue, Chatswood, 2067 Ph (02) 417 4466 Fx (02) 417 5231
Qld:	CF & T Washroom Equipment P/L PO Box 581, Mermaid Beach, 4218 Ph (075) 78 5199 Fx (075) 78 5260
	Moody & Winter Sales Boron Street, Sumner Park, 4074 Ph (07) 376 2455 Fx (07) 376 5415
WA:	Danny Eversden Agencies Unit 11/7 Vale Road, Malaga, 6061 Ph (09) 249 3393 Fx (09) 249 3395
NT:	Brassware Agencies Coonawarra Road, Winnellie, 0821 Ph (089) 47 0019 Fx (089) 47 0349
King & Sons	King & Sons P/L
	Montpelier Road, Bowen Hills, Qld, 4006 Ph (07) 854 1688 Fx (07) 854 1668
Macnaught Industries	Macnaught Industries P/L
NSW:	41-45 Henderson Street, Turrella, 2205 Ph (02) 599 3388 Fx (02) 597 2869
Vic:	5 Howleys Road, Notting Hill, 3168 Ph (03) 543 3466 Fx (03) 543 1426
Qld:	Unit 4, 116 Compton Road, Underwood, 4119 Ph (07) 209 2088 Fx (07) 209 2098

Supplier	Distributors
Northan Distributors	Mike North Sales
	Taunton Drive, Cheltenham, Vic, 3192 Ph (03) 583 8359 Fx (03) 583 9516
	Contact Alan Ryan, all states except Qld.
Qld:	Ramtaps P/L Lavarack Ave, Eagle Farm, 4009 Ph (07) 268 1933 Fx (07) 268 1966
Panametrics	Panametrics P/L
	PO Box 234, Gymea, NSW, 2227 Ph (02) 525 4055 Fx (02) 526 2776
RMC	Reliance Manufacturing Company
Qld:	40 Ross Street. Newstead, 4006 Ph (07) 252 3646 Fx (07) 252 9391
NSW:	4/C Park Road, Regents Park, 2143 Ph (02) 644 3122 Fx (02) 743 7368
SA:	545 South Road, Regency Park, 5009 Ph (08) 243 1277 Fx (08) 243 1675
WA:	6/195 Bannister Road, Canning Vale, 6155 Ph (09) 455 2628 Fx (09) 455 2629
Vic:	Watermain Fittings contact; Peter McLennan Down Street, Collingwood, 3066 Ph (03) 419 6455 Fx (03) 416 0337
Tas South:	Argus Agencies Central Ave, Moonah, 7009 Ph (002) 73 0633 Fx (002) 72 2224
Tas North:	Argus Agencies Glen Dhu Street, Launceston, 7250 Ph (003) 44 7277 Fx (003) 43 1709
North Qld:	Ralph Buck Agencies contact: Mike Buck Mackley Street, Garbutt, 4814 (Townsville) Ph (077) 79 0177 Fx (077) 75 1480
Hervey Bay:	R&M Marketing contact: Bob Orr Caulfield Street, Point Vernon, 4655 Ph (071) 28 1620 Fx (071) 24 1420

Supplier	Distributors
NT:	Brassward Agencies contact: Colin Etter Coonawarra Road, Winnellie, 0821 Ph (089) 47 0019 Fx (089) 47 0349
Spirax Sarco	Spirax Sarco P/L Australia
NSW:	14 Forge Street, Delivery Centre, Blacktown, 2148 Ph (02) 621 4100 Fx (02) 831 8519
Vic:	1/14 Jersey Street, Bayswater, 3153 Ph (03) 729 2277 Fx (03) 720 5224
SA:	Unit 1/54 Deeds Road, Plymton North, 5037 Ph (08) 2948155 Fx (08) 295 5050
WA:	4/6-8 Shields Cres., Booragoon, 6154 Ph (09) 330 5455 Fx (09) 317 2033
Qld:	2/24 Windorah Street, Stafford, 4053 Ph (07) 856 4111 Fx (07) 856 4732
Tas:	Unit 2/18 Ferguson Drive, Devonport, 7310 Ph (004) 24 1773 Fx (004) 24 1773
Shred Tech	Shred Tech P/L
	PO Box 59, Regents Park, NSW, 2143 Ph (02) 743 8322 Fx (02) 743 8933
Spraying Systems	Spraying Systems Australia P/L
Vic:	Locked Bag 15, Hawthorn 3122 Ph (03) 818 1255 Fx (03) 819 1022
Qld:	Ph (07) 232 0460 Fx (07) 232 0422
NSW:	Ph (02) 286 0656 Fx (02) 286 0610
WA:	Ph (09) 325 7499 Fx (09) 325 1509
Spray Nozzle Engineering	Spray Nozzle Engineering P/L
Vic:	1–2, 27 Shearson Cres., Mentone 3194 Ph (03) 583 2386 Fx (03) 585 0218
Qld:	Lato Industries P/L Unit 15, 58 Wecker Road, Mansfield 4122 Ph (07) 849 8633 Fx (07) 849 8091

Supplier	Distributors
Stridhs	AB Stridhs Maskiner Stadsskrivaregatan 9 S – 415 02 Goteberg – Sweden Ph +41 31 84 44 44 Fx +41 31 25 91 25 contacts: Mr Gunnar Furuvik or Mr Christer Appelgren
Viking Powerclean	Viking Powerclean P/L
NSW:	3 Kelso Crescent, Moorebank, 2170 Ph (02) 602 3666 Fx (02) 601 3527
Vic:	218 Princes Highway, Dandenong, 3175 Ph (03) 793 1892 Fx (03) 794 0682
Qld:	754 Beaudesert Road, Coopers Plains, 4108 Ph (07) 275 1388 Fx (07) 875 1395
SA:	Gerni Water Blasters Cnr Charles & Lancelot Sts, Beverley, 5009 Ph (08) 268 7400 Fx (08) 347 3387