Manual of Designs

FOR THE HANDLING AND SLAUGHTER OF
CATTLE, SHEEP AND GOATS

MLA
MEAT & LIVESTOCK AUSTRALIA

LIVECORP
THE AUSTRALIAN LIVESTOCK EXPORT COOPERATIVE

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1. Introduction

The importers of Australian livestock now have access to computer-aided design (CAD) engineering programs, which can provide three dimensional models and plans to help with the best practice housing, handling and slaughter of livestock.

This manual has been produced by the Livestock Export Program, funded by Meat & Livestock Australia, LiveCorp and the Australian Government, to support ongoing improvements in the management of Australian cattle, sheep and goats in export markets.

It is an update and expansion of the feedlot design module in the Manual for South-East Asian Cattle Feedlots, and provides valuable, practical resources for use in ports, farms, feedlots and abattoirs. This includes design options for abattoirs that process both Australian and local cattle in parallel.

2. Background

The cattle, sheep and goat yard designs in this manual are suitable for both privately operated and public South-East Asian and Middle East and North Africa (MENA) abattoirs and slaughterhouses.

The following factors have been taken into consideration:

- ESCAS (Exporter Supply Chain Assurance System)
- OIE (The World Organisation for Animal Health) compliance for all equipment and facility designs
- The high cost and scarcity of suitable land for livestock production and abattoirs
- The best utilisation of locally available construction and fabrication materials
- The need to be able to process local, led cattle in small numbers and imported cattle using the same facilities
- The safety of the people working in the facilities
- The colour and shelf life of the meat processed
- The welfare of the livestock using these facilities
- The principles of low stress stock handling and natural livestock behaviour.
- All the designs in this manual make best utilisation of fabrication material lengths, i.e. minimum cut offs
- This manual will follow the principle that a “slaughterhouse” is a place to slaughter livestock with the majority of slaughterhouses releasing unchilled meat
- An “abattoir” is a slaughterhouse with the addition of a chiller and may carry out further processing i.e. deboning and packaging
- An objective of this manual is to publish plans from a number of previously industry funded equipment projects.
3. How to view the manual’s PDF designs in Adobe

Engineers and draftsmen should click on the link below to download a free copy of DWG Trueview which opens .dwg files. It can view, print and track changes to Autodesk 2D and 3D design files without the original design software.

http://www.autodesk.com/products/dwg/viewers

The following Figure 1 illustrates how to view a .dwg file in TrueView.

Figure 1 Illustration of how to view a .dwg file in TrueView.
All manual PDF designs will either be viewed as an A4 or A3, all need to be viewed at 100% for clarity. See Figure 2.

When a PDF is opened in the manual, it is to be viewed at actual size. In this case this is 100%. This will assist with the clarity and the scale in the design.
This figure will describe the functions of the various "Title Blocks" displayed in the manual. A title block is inserted into each design and gives details related to the figure. Here are some examples.
During 2012, the Livestock Export Program developed comprehensive cattle and sheep “work instructions” for facilities and equipment. Equipment in this manual has been designed to suit the work instructions which have been developed for ESCAS. Work instructions have associated documents, in the example below the associated document is SOP 5: Slaughter with stunning. Figure 4 is an example of a work instruction or user guide for specific equipment. To access these documents contact livecorp@livecorp.com.au

### 4. Site selection

Livestock industries in all countries will always benefit from sound planning prior to the construction of any animal handling facility. This applies to the construction of feedlots, lairage and abattoirs.

The first step is to understand and satisfy local government requirements, in particular the environmental standards and guidelines related to the siting and licencing of facilities. For example, effluent treatment which complies with government regulations is essential.

There are of course many other planning contingencies including:

- Having sufficient water on site which is suitable for livestock to drink and in the case of an abattoir, enough potable water to meet daily and long-term requirements
- Access to adequate stockfeed ingredients to meet livestock requirements
- All weather access, and
5. Construction materials

Over the last 40 years, the temperament and tractability of Australian livestock has greatly improved to the point where most Australian livestock remain calm during most handling events. To maintain this status quo we need to keep on improving our low stress handling and meeting the nutritional requirements of sheep, goats and cattle. Animals will only cooperate during short periods of isolation after which they will stress.

One of the many benefits of having calm, unstressed cattle will be that equipment and construction requirements will be less expensive. For example:

- Suitable protection for livestock from weather extremes during transport or in a feedlot and lairage. Historical weather information will help in assessing risks and is available on a number of web sites. Five years of history is common with access to temperature, snow days, rain days and heat days. Refer to Figure 5.

Appendix 1 shows a table of critical cold temperatures incorporating the wind chill factor. Sourced from Feedlot Management Guide www.gov.ab.ca

Appendix 2 shows a table of critical hot temperatures incorporating relative humidity. Sourced from Livestock Conservation Inc. Kansas City, Kansas

The main danger of freezing temperatures in feedlots is the chill factor due to the increase in wind speed at very low temperatures. Most feedlots in the danger regions are now monitored with data loggers that alert management of the wind chill danger. Extreme hot weather can also be alerted through the monitoring of feedlot and lairage temperature with data loggers.

Figure 5 An example of how to retrieve 5-10 years of weather. Source: https://weatherSpark.com.
• Feedlot panels and gates will not need to be so high for all species
• Construction materials can be of lighter material (e.g. black pipe OD 88.7mm with a 4mm wall can be replaced with a 3mm wall), and
• A four railed panel may replace a five railed feedlot panel or gate.

Due to the high cost of construction materials in most countries, this manual has taken the approach to not over-design facilities and equipment so as to optimise the costs of construction.

At the time of preparing this manual, mild, steel, black pipe and mild, steel, plate are the preferred building materials along with reinforced concrete. The designs in this manual have attempted to make the best use of the building materials with minimum off-cuts. All steel posts that are in the ground are protected from saline soils and livestock effluent with the addition of a PVC pipe sleeve protruding above plinth level.

6. Abattoir lairage

The word lairage translates to a place where animals are held prior to slaughter.

6.1 Lighting

In ante-mortem pens a minimum overall illumination of 110 lux must be provided. In any ‘suspect’ pens (where veterinary post-mortem inspection is required), a minimum overall illumination of 220 lux must be provided.

The intensity of lighting required to be provided at work stations is as follows:

• In the case of ‘suspect’ pens, yards and lairage (where veterinary post-mortem inspection is required) - 220 lux measured 1 metre above the ground.
• In the case of covered livestock pens (lairage) - 110 lux measured 1 metre above the ground.

Source: Construction and Equipment Guidelines for Export Meat. (Department of Primary Industries and Energy)

Livestock will naturally move from a dark area to a lighted area
But not from a lighted area to a dark area

The ideal lighting to move livestock is during daylight hours and sometimes during a full moon that is overhead; both can provide suitable lighting for the movement of stock. In most circumstances livestock can see better than the stock workers. This is an important point to remember when designing equipment or positioning light fittings. Fluorescent lighting is compatible with livestock as it tends to be softer and more diffuse than other forms of lighting. Fluorescent lighting does not create as many shadows which can distract livestock.

A “black hole” is where livestock can only see a dark area in front of them and they will balk and not move forward under their own free will. Image 1 (see next page) shows the erect ears of the sheep at the front of the line indicating that they do not want to move forward in the race as they cannot see a sheep in front. Similarly, noisy machinery or equipment should not be anywhere near livestock being moved. Such machinery and equipment should be relocated away from livestock.
Image 1 Erect ears of the sheep indicating that they do not want to move forward (top). 'Black hole' effect, impeding the flow of livestock (bottom). Source: Geoffrey Beere.
Figure 6 (a) and (b) illustrates the correct and incorrect placement of light in cattle/buffalo pens. A poorly positioned overhead spot light casting shadows from the steel rails in laneways will baulk cattle.

Figure: (a) The correct light placement in a cattle/buffalo forcing pen.

Figure: (b) Florescent lighting casting shadows.

(A poorly positioned overhead spot light casting shadows from the steel rails in laneway — these shadows will baulk cattle.)

Figure 6 (a) and (b) The correct and incorrect light placement in a cattle/buffalo forcing pen.
Source: Andy Sufri Mohd Johari.
Similarly, Figure 7 (a) and (b) illustrates examples of correct and incorrect lighting in sheep pens.

**Figure:** (a) Correct positioning of lighting to minimize shadows.
- Suspended 2-3 metres from floor level.
- Lighting should not sway in the wind.
- Fluorescent lighting offers the most suitable lighting.
- Livestock will move towards lighter areas.

**Figure:** (b) Incorrect lighting positioning.
- Dark areas and shadows will baulk livestock.
- Livestock will not move towards dark areas.

Figure 7 (a) and (b). Correct and incorrect positioning of lighting in sheep pens. Source: Andy Sufri Mohd Johari.
6.2 Site selection

The location of an abattoir and lairage should minimise the impact of the development on the local community and the environment. The abattoir and lairage sites should be at least 100 metres from the feedlot pens, buildings used for human habitation and any factory, public road or any public place that is likely to use meat or meat products. Potable water, electricity and adequate drainage facilities, including the disposal of abattoir effluent, storm water, site drainage and sewage disposal must also be available.

To minimise the risk of airborne contamination of meat, lairage holding pens cannot be within 9 metres (Construction and Equipment Guidelines for Export Meat, 1990) of any part of a main building in which carcase dressing takes place or meat is processed. This provision does not apply to a building used for stunning or slaughtering, provided no meat processing or dressing operations are carried out in that building. In all circumstances the abattoir needs to be at a higher elevation than the feedlot and the effluent treatment area.

The area should be free of dust, odours and located away from city dumps and sewage disposal systems. Undesirable soil types that are subject to significant expansion and contraction should be avoided, as should heavy soils that are subject to water logging. Sites subject to flooding or rising water tables must be avoided.

6.3 Stocking density

Lane ways and forcing pens should not be included in the equation when calculating pen areas. Pen areas should be calculated on the basis of approximately 2-4 square metres per slaughter animal depending on the size of the animals. There should be sufficient space for all the cattle in the pen to lie down, turn around and rest. Refer to Appendix 3, ESCAS Animal Welfare Standard, Standard 9.2.

6.4 Drainage

Storm water and storm water runoff, should be diverted away from the lairage and not be mixed with existing lairage runoff in the anaerobic and aerobic effluent ponds.
The pen area space should be roofed and rain-proof in wet climates, and have paved or concreted floors. This manual promotes the dry cleaning of cattle pens (solids) prior to washing, so as to be able to reduce the amount of solids in the effluent. This will also support a growing organic fertilizer industry in importing countries.

A graded or sloping concrete pen floor with a broom finish is the best. It is important that the placement of any drains inside pens, laneways and ramps be avoided to minimise any injury to cattle. The shadows caused by drains also baulk cattle when they are moved. Spoon drains are recommended in preference to rectangular or straight-sided drains. There should be sufficient sheltered pen floor area in the abattoir holding yards to hold cattle, sheep and goats for one day’s production. See Figures 8(a) and 8(b).

Internal rectangular drains in cattle lairage and pens should be avoided due to the risk of livestock injuries and the baulking of cattle.

Spoon drains (spoon shaped) have no corners or covers, therefore are an efficient means of moving solids and water away from the lairage for treatment. Spoon drains cast a minimal shadow from sunlight or artificial light resulting in less baulking. Figure 9 (see next page) illustrates the preferred spoon drain design, and the grade or fall in the drains.
Spoon Drain Details.

Non skid surface pattern pressed into wet concrete.

Spoon drain has a fall of 2% ie. 0 to 0.3m over 15m Note radius shape & no sharp edges.

Figure 9 Diagram of preferred spoon drain. Source: Beere Engineering.
A common observation (see Figure 9, previous page) is that drainage in new/old feedlot lairage pens is already up to 30cm deep at floor level. All drains should start at floor level, zero. Steel covers on drains should always be avoided.

6.5 Flooring

A graded or sloping concrete pen floor with a broom finish is best. The use of a stiff, straw broom results in a particularly good, non-slip finish (Figure 10 and Figure 11).

![Figure 10 A stiff broom used to roughen the new concrete floor surface prior to hardening provides a non-slip surface for cattle.](image1)

Figure 10 A stiff broom used to roughen the new concrete floor surface prior to hardening provides a non-slip surface for cattle.

![Figure 11 Brush strokes should be at 90 degrees to the direction of livestock movement.](image2)

Figure 11 Brush strokes should be at 90 degrees to the direction of livestock movement.

Different patterns in the concrete can baulk or stop cattle from moving forward. It is all about depth perception. Uneven lines, shadows and deep drains on the flooring will baulk the movement of livestock. Refer to Figure 12 (see next page).
Cattle may refuse to walk over a drain.

Figure 12 An example of where cattle may lack depth perception and baulk. Source: Dr Temple Grandin. http://grandin.com

Figure 13 shows a surface ideal for the flooring of trucks, loading/unloading ramps and where livestock require extra grip.

Figure 13 An example of effective non-slip flooring. Source: LEP training in animal handling.
6.6 Emergency slaughter

In all planning for the siting and design of lairage, consideration should be given to the receiving of downer animals (unable to stand or walk) or the emergency slaughter of livestock. Where stunning can be applied to downers, the issue is reduced as the animal, after veterinary inspection, can be stunned on the vehicle. In some instances, downer animals can be slaughtered successfully in the vehicle depending on the skills of the stockperson.

Dowler cattle, sheep and goats should not be dispatched from the feedlot. Such animals should receive veterinary treatment at the feedlot and if necessary be humanely disposed of on site.

7 Cattle and buffalo planning

In this section, the subtle differences between the equipment utilized for cattle and the Australian water buffalo [*Bubalus bubalis*] will be addressed. A significant difference between the two species is that buffalo have less tolerance to direct exposure to the sun and hot weather than cattle (buffalo are only able to sweat from their nose; they regulate their body temperature with the use of water or a wallow).

This can be managed with the use of water spray/mist directed onto the animals. It is important that stockpersons and managers are able to identify the first signs of heat stress in buffaloes which is normally the animals displaying an increased respiration rate, reddening of the hide, facing up to the stock person, and in advanced heat stress, a stiff gait.

Buffalo will need to be managed through a yard or treatment in the cooler times of the day. Once this is understood by stock workers, it will be much easier to work with buffalo.

A buffalos’s response to an electric goad is to face the danger, hence goad use is detrimental or has a negative effect on low stress stock movement.

Buffalo will move into a race with the same ease as cattle, the standard being 71cm wide; however the buffalo will need to believe that this is the way out. Buffalo behave the same as male goats and rams and will turn their head sideways in the race and feel their way with their horns. The widest fixed part of cattle and buffalo is the hips.

Many a stock worker has been beaten by a buffalo at a slide gate; this is due to the bullet shape of the buffalo’s head. For this reason, bail gates make an excellent race gate when working with buffaloes (bail gates close equally from both sides to the centre).

Buffalo do not generally jump gates or panels as cattle might, although buffalo castrates tend to jump more than buffalo bulls. Both cattle and buffalo respond favourably to 45° corners, curved races, low stress stock handling and strategically placed panels for ease of movement.

In summary, both cattle and buffalo can use the same equipment provided the stockperson appreciates the differences in animal behaviour.

The first considerations in building infrastructure for cattle and buffalo are:

- The availability of suitable land and site
- The design of the infrastructure to suit the livestock involved, and
- Available construction materials and the overall cost of construction.

7.1 Building yards for cattle

Often feedlot and abattoir operators have difficulty in pegging out a site for a feedlot or lairage. The diagram Figure 14 (see next page) gives a good introduction on how to draw or mark out a site prior to construction.
7.1.1 Yard designs

There are many options offered by Australia’s State Departments of Agriculture for yard designs and they are freely available on web sites such as www.dpi.nsw.gov.au/agriculture.

The majority of beef cattle yard designs at these sites can be fabricated from materials referred to in this manual. Figure 15 (see next page) shows the basic essentials for a cattle treatment yard suitable for feedlots and in some cases the design could be adapted as an ante-mortem facility for a large slaughterhouse/abattoir. The addition of a paved floor and a suitable roof would be required for the majority of countries. All the components shown in this design are contained in this manual. Essentially you can take almost any design from web pages and other sources and use the components such as swing gates, panels, raceways contained in this manual to fabricate a complete yard/lairage to your requirements.
Figure 15 A basic cattle treatment yard design. Source: NSW Department of Agriculture.

This design is found with others at the NSW Department of Primary Industries web site.

All equipment to fabricate this cattle yard for 100 head can be extracted from the manual designs.

Loading and unloading ramp.

Sliding gate.

Steel post with steel rail or cable.

Optional height/length steel yard panel.

2500mm Swinging gate.
7.1.2 ‘V’ force yard

The words “V force” in this instance refer to the design or shape of the area where cattle are moved from a laneway into a raceway.

The plan in Figure 16 (see next page) shows an abattoir/slaughterhouse yard plan, with the concept being to minimise the use of 90 degree corners and replace them with 45 degree and 135 degree corners. The plan allows for the addition or deletion of angle pens.

This design illustrates the use of four angle pens. Each pen is 3 metres wide and 14 metres long, and can hold up to 15 slaughter weight cattle. Pens can have a greater length than 14 metres but if so, a dividing swing gate should be fitted. Cattle pens with a separate entrance and exit gate makes it easier to move imported cattle.

This design offers the option of two cattle restraining or stunning boxes. It is not unusual for an abattoir in the importing country to have more than one restraining or stunning box. This manual uses a V force design that works and if necessary can be adapted and used to modify existing yards.

7.1.3 ‘D’ force yard

The term “D force” yard in this instance refers to the design or shape of the area where the cattle are moved from a laneway into a raceway. The overall design of this lairage yard is the same as the ‘V’ yard; it is the design of the forcing area that is different. Refer to Figure 17 (see page 29).

It is advantageous to line the inside perimeter of the ‘D’ with rubber sheeting or used conveyer belt fixed to the pipe rails to a height of 1.6 metres.

In both the ‘V’ and a ‘D’ force yard designs, the direction of the Kiblah (Mecca) is labelled with a ‘West arrow’. The position of the Kiblah will determine the positioning of the restraining /stunning boxes, however the ‘D’ and the ‘V’ yards can be positioned to make the most economic use of available land to accommodate the yard. One of the biggest costs of constructing an abattoir and lairage is the cost of suitable land.

8 Port infrastructure and equipment

8.1 Port ramps or trailers

Having suitable equipment and infrastructure for discharging livestock at the port is essential. The main constraints at ports are:

- Untrained personnel, with no stock sense, will cost in time and stock injuries
- Incorrectly positioned lighting over the port ramp, where stock are unable to see the way
- The lack of visual barriers to remove personnel from the cattle’s line of sight
- Port trailers with incorrect dimensions in relation to available berth space and surrounding port sheds, and
- Cattle escaping at the port ramp.

To overcome these constraints and others, there is excellent training material which includes work instructions, standard operating procedures and videos. Refer to the two links below.

Standard Operating Procedures for the Welfare of Sheep in Overseas Markets
Standard Operating Procedures for the Welfare of Cattle in Overseas Markets

Figure 18 (see page 30) shows the drawing for a simple, reliable port trailer for cattle; assembly drawings included in Figure 18.
Figure 16 A complete V force yard showing lairage pens. Source: Beere Engineering.
Figure 17 A complete D force yard design. Source: Beere Engineering.
Figure 18 Design of movable port ramp to unload cattle (4 views). Source: Tonny Sitorus, Engineer, Indonesia.
Figure 19 shows an Indonesian port cattle ramp and its adaption to work in the Middle East.

Source: Tonny Sitorus, Engineer, Indonesia.

A = INDOONESIAN PORT TRAILLER
B = MIDDLE EAST TRUCK DECK
C = MIDDLE EAST TRUCK DECK (MIRRORED)
There is also another port ramp design adapted to Middle East stock transport vehicles. This design has two individual truck bays which allow a tailgate to be lowered to the deck of the platform. The tailgate can then be closed before the truck leaves the security of the bay. See Figure 20.

Figure 20 Fabrication, assembly drawings of port ramp adapted for Middle East. Source: Tonny Sitorus, Engineer, Indonesia (a combined 8 page PDF).
Figure 21 Port cattle unloading trailer. Source: Beere Engineering.

- Light hung over each truck bay
- Extra non-slip reinforcing mesh around corner
- Locking handle on each drafting gate
- Shade cloth vision screen on 2 sides of platform
- Slide gate separation between races
- 45° entrance to raceway for variations in ship ramps
- 2 mm thick plate on fence & gate panels
- Separate platform with dual raceways for alternate loading options
- Truck tailgate operator behind protective fence
- Shade cloth vision screen on 2 sides of platform
- Locking handle on each drafting gate
- Extra non-slip reinforcing mesh around corner
- Light hung over each truck bay
- Slide gate separation between races
- 45° entrance to raceway for variations in ship ramps
- 2 mm thick plate on fence & gate panels
- Separate platform with dual raceways for alternate loading options
- Truck tailgate operator behind protective fence

Dimensions in mm:
- Length: 11100
- Width: 6986
- Height: 3600
- Depth: 470
- Side: 2700

Port Cattle Unloading Trailer
The port trailer/ramp design shown in Figure 21 (see previous page) has the potential to be very efficient at transferring cattle from the ship to the local cattle trucks and should suit most countries. The trailer design allows for trucks with dropdown tailgates or sliding rear gates to load while reducing the risk of escaping livestock.

It is proposed to add an optional 90° curve to the race from the ship as well as a straight approach. This can be fitted to a platform to allow the trailer to be parallel to the ship. In a number of the world ports there is often limited access for trucks, hence this option will allow flexibility in the positioning of trucks relative to the ship. The design allows animals that are showing any signs of injury or weakness to be segregated from the rest of the animals being unloaded. This is achieved via the four overhead-operated race drafting gates.

There are two race options on the platform that join the ships race to the port trailer, which offers the option of unloading via a straight race or a 90° race. The 90° option will reduce the cattle baulking when descending a straight race. Another feature is that both the straight and curved race option have a V, or lead in panels so that the varied dimensioned ships’ races can fit and be stock proof.

8.2 Truck modifications

In some countries, the majority of the trucks used to transport cattle from the discharge port to the feedlot have a dropdown tailgate. Cattle will definitely jump out from the back of this type of truck. Image 3 shows a fabricated and standardised rear panel for the truck with a slide gate to overcome this problem. Note the removable mesh floor to minimise slippage by cattle during transport.
Figure 22 shows another option for the rear gate of a typical general goods truck.

Figure 22 Design modifications to truck with dropdown tailgate. Source: Tonny Sitorus, Engineer, Indonesia. A combined 3 page PDF (assembly drawings).
9 Unloading ramps at feedlots and abattoirs

The design shown in Figure 25 (see page 39) is the minimum standard for an unloading ramp. The area that it occupies has been minimised mainly due to the cost of land and the increasing cost of all construction materials. The reason a single file loading race has been included in addition to the wide, unloading ramp is that ESCAS approved meat traders might purchase cattle at one feedlot or abattoir holding yard, reload and relocate them to another feedlot or abattoir.

The trucks that transport cattle are of varying sizes, so it is difficult to select a height of a ramp that will suit all vehicles. The design in Figure 24 (see page 38) includes two swing gates, one which is 1 metre long and the other which is 2 metres in length at the top of the ramp to allow for the majority of Asian and Middle East and North African trucks that have a dropdown tail gate. A minimum of 2mm mild steel plate is fixed onto this loading/unloading ramp, as it allows cattle to better sight the openings and a way forward. Please observe that on all ramps, including port ramps, the leading edge of the ramp must be protected from livestock transport drivers that use the ramp to physically stop the truck when reversing. This protection is provided with the use of a UNP steel beam.

Incorporated into the design of the loading/unloading ramp is a simple sliding gate based on a proven design, Figure 24. This design is favoured due to its simplicity and it can be fabricated from material available at hardware shops in all countries. The plated side of the gate must face the exposed tail bone (coccygeal vertebrae) of the cattle or buffalo. The only maintenance is that WD40 (lubricant) or light paraffin oil is used on the two gate slides (identified as ‘sliders’ in the design) positioned at the top of the gate. Oil or grease collects sand/dust and can cause the gate to seize.

10 Feedlot designs

The design of feedlots will depend to some extent on the locality, however there are several important principles when planning a feedlot.

10.1 Shade

The experience with erecting shade over livestock in our diverse world markets is that it can be in the wrong place at the wrong time of the day. This can be due to the specific location, the region where the feedlot lairage is located and will of course depend on if it is summer or winter.

Sixteen sites from livestock import countries were chosen to demonstrate the changing position of the sun. There is enough variation in the shadow cast by the shade structure to compare the 16 sites. These sites are:

Amman, Bahrain, Bangkok, Beirut, Cairo, Dubai, East Turkey, Hanoi, Istanbul, Jakarta, Kuala Lumpur, Kuwait, Manila, Oman, Qatar and Saigon.

As an example, Figure 23 (see page 37) shows the sun’s position at 09:00, 12:00 and 15:00 hours at Amman and shows the position of the sun on the longest summer day and winter’s shortest day. This information is intended to give developers the means to position the shade structure in a pen for the greatest shade/shadow time.

In Australia the height of the shade structure is usually 6.5metres, determined by the size and height of the machinery that will be used to clean or maintain the feedlot pen surface. For Middle East importers the pens are not usually cleaned as often due to the lack of rain, hence the shade structure height of 4.5metres has been used. Asian importers have to incorporate rain protection as well as shade. Where possible, if a pen floor needs to be concreted it should cover 100% of the floor surface; there are many instances of livestock standing in the mud rather than on the concrete surface.
Figure 23 Position of shade during winter and summer in the Northern Hemisphere.
(multi-page PDF showing different locations)
Figure 24 Design of Willie Taylor sliding gate. Source: Willie Taylor.
Figure 25 Minimum design for cattle loading/unloading ramp. Source: Beere Engineering.
10.2 Reducing bulling (buller syndrome)

Bulls that are being mounted/ridden in feed pens are usually targeted when they are at the feed trough or bunk. By placing or fixing overhead, steel panels in the corner of the feed pen; Figures 26 & 27 (see pages 41 & 42) allows the targeted bulls to have protection from mounting. This is an important issue in some countries where all local dairy and beef progeny are raised as bulls. Imported Australian bulls are also observed to aggressively chase and mount other bulls in the feed pens. This design is of practical assistance in a growing feeder bull market. Bulls are observed to mount more frequently in lairage with resulting meat pH, colour and tenderness issues. Only a small area of the pen, approximately 5-10% needs to be covered with panels, as bulls soon learn where the shelter is in the pen.

Other features in the same design (Figure 26 & 27) include:

- A cable tensioning concept that replaces expensive and unreliable turn buckles. Tension is applied via the chain and retained by the fitting of a mild steel bar or similar
- A simple system that allows the feed bunk cable height to be adjusted easily to cater for growing cattle (Source: Dr Temple Grandin), and
- A precast concrete trough for feed is contrasted with a design for feeding on to a sloped concrete plinth. The latter is comparatively cheap to construct and to manage, but only suitable for low rainfall regions.

11 Abattoir/feedlot races and laneways

Lanes are the preferred method of moving livestock between and around facilities, such as to or from unloading ramps, races, pens, lairage and restraining boxes.

The movement of cattle within feedlots and lairage has been addressed by various publications available on the LiveCorp website (www.livecorp.com.au). Australian cattle and buffalo on arrival in importing countries tend to be comfortable to move in groups as part of their herding instinct.

Compared to Australian cattle and buffalo, European beef and dairy cattle are much more familiar and calm when standing in a queue or line and in the confines of a straight sided race. European livestock behave this way as entering a race or confined space has been normalised through incentives like milking, bedding, feeding and supplementation. Australian cattle and buffaloes do not experience the same level of domestication or feeding in close confines and therefore are generally more anxious when separated or confined.

Straight sided races are preferred to a “V” sided race. Cattle are inclined to try and push past each other in a V sided race and can jam. Cattle that lay down in a V sided race are also at greater risk of becoming jammed.

A visit to a large abattoir in France revealed a new welfare regulation that requires all animals standing in an abattoir race to be separated by a sliding gate. This new requirement, if introduced to importing countries, will add significant cost to upgrading or installing new infrastructure. This is a strong reason to shorten races accordingly. It will be difficult to separate bulls with the use of slide gates unless the operator has good skills.
Figure 26 Feedlot overhead panel design (bull refuge) - view 1. Source: GOKTASLAR Gaziantep, East Turkey.

Feed Lot Corner Plan
Scale 1:40

Feed Lot Corner Elevation
Scale 1:20
Figure 27 Feedlot overhead panel design (bull refuge) - view 2. Source: GOKTASLAR Gaziantep East Turkey.
An abattoir processing less than 100 cattle per day, should have only two cattle standing in a race prior to slaughter. See Figure 28. Cattle and buffalo waiting in a 3 metre wide lane are normally less nervous and anxious than waiting in a much narrower raceway.

Figure 28 Cattle laneway leading to restraining box. Source: Geoffrey Beere.
The laneway model shown in Figure 29 shows a 3 metre wide lane connecting a feedlot to lairage pens and an abattoir.

Where spoon drains cross/transect lanes at 90° they should be constructed with material the same colour and texture as the floor and not be that deep that they display a shadow. Both issues will stop cattle movement.

Figure 29 An example feedlot to an abattoir lane. Source: Engineer Raed Hijazi Ismailia, Egypt.
12 A cattle feedlot herringbone pen gate system

In feedlots it is essential that cattle, stock persons and pen cleaning equipment have easy access to pens. The herringbone design facilitates easy access and improves the flow of cattle. The design in Figure 30 shows cables replacing steel rails. In a number of livestock importing countries, second-hand high tensile power lines can be purchased on a weight basis. This plan also shows details on optional pen and gate heights. This design assists with the smooth flow of livestock from pens to laneways, and allows easy access for pen cleaning equipment.

Figure 30 Pen and laneway access in a typical herringbone system. Source: Beere Engineering.
Figure 31 shows a design from an Alberta Feedlot Management Guide. It is a good demonstration of where to position feed pens in relation to loading ramps, drafting and treatment areas. It also demonstrates pen panelling to suit the conditions of ice and snow.
13 Cattle panel and gate design

Figure 32 (see next page) shows the design of a typical cattle panel with an optional height extension and an optional length. The optional height may be used in perimeter or boundary fencing, or where the size of the cattle or the level of security needs to be improved. A swing gate is the name given to a gate that is usually hinged at one end and swings through 180°. The swing gate in these yard part plans has a steel plate fitted and this not only adds strength but also acts as a visual guide for cattle. All of these designs can be used in any new yards or lairage.

The design in Figure 33 (see page 49) shows a number of important details including:

- Pipe welding details
- Plastic PVC sleeve for posts
- Concrete plug for steel posts which is essential in high rainfall areas. The concrete plug is poured onto a squashed cement bag rammed down the open post orifice. The plug and the concrete fixing the post are poured at the same time, and
- Gate hinge/pivot materials which can be purchased from a typical hardware shop.

The V forcing pen design is shown as it demonstrates how to deliver cattle to two abattoir restraint boxes. In many importing countries, abattoirs might have a restraint/slaughter box for a single customer or several customers. The design shown in Figure 34 (see page 50) will help cattle to be delivered to the point of slaughter with minimum stress. Note that sliding gates are plated on the inside to minimize rump/ tailbone bruising.
Figure 32. Cattle panel and gate design. Source: Beere Engineering.

Spacing details of typical cattle panel showing optional height extension for perimeter fences. Scale 1:20

Standard cattle drafting gate
Scale 1:20

Alternate gate locking pin system.
16 to 20Ø pin with 20 to 25NB pipe sleeves

Beere gate pivot with 6 thick plates welded to post
Gate frame is 60 OD x 4 pipe flattened slightly on ends for weld strength

Typical Cattle Fence Panel & Gate
Dimensions in mm
Scale A3

Drawn by D. Beere
Drawn 02/04/14
NTS
Figure 33 V forcing pen showing construction details. Source: Beere Engineering.

Layout Dimensions in mm.

Drawn by D Beere 05/11/14 NTS

V Forcing Pen

Rail pipe is flattened on the end to half its diameter and fully welded to post.

Beere gate pivot with 6 thick bottom plate welded to post
Gate frame is 60 OD x 4 pipe flattened slightly on ends for weld strength

10 thick chain securing gate in position slot in 10 thick plate

2mm thick MS panel welded to inside of race

Beere gate pivot with 6 thick top plate & 48 OD pivot pipe

Posts all set in 150 dia x 200 plastic pipe filled with concrete and protruding 100 above ground level.

Rail pipe is flattened on the end to half its diameter and fully welded to post.

Beere gate pivot with 6 thick top plate & 48 OD pivot pipe

Posts all 89OD x 4 thick pipe with 200 deep plug of concrete for seal.

Printable Click & Print Onto A3
Figure 34 Model of V forcing pen. Source: Beere Engineering.
14 A Bud Box forcing pen

The design modelled in Figure 35 is a popular yard design from the USA. There are a number of video clips on the internet that demonstrate the operation of this concept. The cattle are moved into a blind lane (4.0m wide) and a plated gate is closed behind them by the stockperson. The stockperson then positions himself or herself as illustrated. The cattle will look and find an exit. The only issue is that cattle may want to move into the race in pairs therefore exposing their hips and ribs to the post at the entrance. This issue will be minimised if the cattle are handled using low stress techniques. The principal of why the Bud Box works is that the exit must be as close to the entry gate as possible and cattle must move past the exit gate when entering the forcing yard. This system will allow cattle to move into a raceway, onto a ramp, onto transport and into a restraining or stunning box.

Figure 35 Model of Bud Forcing pen. Source: Hi Hog. Handling Equipment, Calgary, Alberta.
15 Cattle drafting systems

A three way cattle draft is included in this manual as it is an essential part of any feedlot, cattle yard/lairage. This simple design is modelled in Figure 37 (see next page). The inclusion of this drafting concept into feedlot treatment yards will save the industry a significant amount of money by reducing stock injuries through the easier sorting or drafting of cattle. For a number of years, imported cattle were selected and slaughtered by pen, resulting in large variations in carcase weight and fat thickness, as a result of not being able to draft livestock immediately prior to slaughter. Generally the facilities in importing countries are lacking in drafting facilities. ESCAS supply chains require a simple system to scan cattle ear tags and draft.

16 Entering the restraining box

The model in Figure 36 shows a curved race entrance to the restraining box at an abattoir.
Figure 37 Model of three-way draft facilities. Source: Sid Parker.

Layout Dimensions in mm.

Drawn by D Beere 29/12/14 NTS

Posts all 89OD x 4 thick pipe with 200 deep plug of concrete for seal.

Beere gate pivot with 6 thick top plate & 48 OD pivot pipe

posts set in 150 dia x 200 long plastic pipe filled with concrete and protruding 100 above plinth level.

Beere gate pivot with 6 thick bottom plate welded to post

Gate frame is 60 OD x 4 pipe flattened slightly on ends for weld strength

Concrete plinth

300 dia hole filled with concrete

10 thick plate with curved slot for 10mm chain to fix gates when needed.

Shade cloth for vision barrier.

Open tread non slip grating

Handle extension for operating gates

Sid Parker 3 Way Cattle Draft & Treatment Race

Printable

Click & Print Onto A3

Perimeter Cattle Panels
1.9m high, 2m long

Willie Taylor sliding gates

Standard Cattle Panels
1.6m high, 2m long

Handle extension for operating gates

Open tread non slip grating

Perimeter Cattle Panels
1.9m high, 2m long

Willie Taylor sliding gates

Standard Cattle Panels
1.6m high, 2m long

Concrete plinth

300 dia hole filled with concrete

10 thick plate with curved slot for 10mm chain to fix gates when needed.
Moving cattle from a laneway to a single-file race prior to slaughter requires good yard design. The model shown in Figure 38 illustrates the use of a forcing pen with sheeted sides, to encourage cattle to walk towards the restraining box. The forcing pen and single-file race (shaded blue) should hold no more than 3-4 head. This is an example of upgrading a slaughterhouse in a simple way to be able to receive ESCAS cattle.

The design modelled below in Figure 39 (see next page) shows an abattoir lairage with a V shaped forcing pen. The races are 71cm wide, and the entrance to both boxes is at 90° to the raceway. Both of these aspects of design cause a lot of discussion in importing countries. It should be noted that:

- The widest part of a buffalo or cattle is the hips. Measurement can be done when the stunned animal is laterally recumbent and a tape measure will show that the hips will not be greater than 65cm
- Cattle and buffalo are observed to lick their rumps in the field or feedlot. This indicates that they are able to negotiate a 90° bend, and
- All stunning and restraining boxes in the manual have a double florescent light suspended above the centre of the boxes to minimize shadows.

17 Restraint box with head restraint for stunning

Figure 40 (see page 56) shows a restraint box developed specifically to allow head restraint and stunning. This box was developed through the Australian Livestock Export Research and Development Advisory Committee (LERDAC) specifically to comply with ESCAS requirements. This restraint box has been replicated in a number of Indonesian slaughter floors and suits either a hand held stunner or a pneumatic stunner.
Figure 39 Model of laneways to V-shaped forcing pens. Source: Beere Engineering.
Figure 40 Model of restraining box with head restraint for stunning. Source: Paul Troja drafted by Beere Engineering.
HYDRAULIC HALAL RESTRAINT BOX
MARK IV OIE APPROVED

Features:

- Access full opening walk in
- Hydraulic controls mounted on pivot arm
- Body & head restraints and “rollover” operated with individual single cylinder hydraulic rams
- Rubber cushion support
- Full side gate for easy access
- Heavy duty construction duralgal material
- Hot dipped galvanised
- Full checker plate floor
- Grease nipples fitted to moving joints where necessary
- Single phase 2.2kw electric motor
- Oil capacity 45 litre holding tank
- Hydraulic pump immersed in oil & direct coupled to motor
- 9.4 litre per minute pump @ 1400rpm
- Manufactured weight is 1000kg

Restraint Box MKIV has been approved to the standard of the world organisation for animal health (OIE) code.
NOTE: This Manual contains important information on the operation and safety of this HYDRAULIC HALAL RESTRAINING TABLE. Before commencing any operation read this Manual carefully and familiarise yourself with it. Instruct all users and potential users of this machine in its proper operation and use as per this Manual. Keep this Manual in a safe accessible place where it cannot be damaged. This manual shall be considered as a permanent part of the machine and shall remain with the HYDRAULIC HALAL RESTRAINING TABLE if it is resold.
Figure 43: Three-dimensional model of a Mark IV cattle restraining box.
Image 4 Demonstrating the means of cattle restraint in a Mark IV, and the position of the box when tipped to 90°.
18 Retrofitted head bail design for stunning boxes

Figure 44 shows the design for a head bail which can be retrofitted to a stunning box. This retro fitted head bail was designed and tested under the supervision of Meat & Livestock Australia consultants in Indonesia during 2012 and led to the fitting of head restraints to existing cattle restraining boxes in Indonesia and Malaysia. Retro fitting of this type will also be a practical modification for any restraining boxes that are upgrading to percussion or pneumatic stunning.
19 Cattle water and feed troughs

Figures 45(a) & (b) show a water trough design to supply cool water to livestock. The internal shape of the trough is very shallow and does not allow water that stands for a long period in the tropics to heat up. The provision of cooler water encourages higher feed intakes. The construction material for this design is concrete blocks and concrete plaster which is suited to the Philippines. Please refer to Figure 26 & 27 (feedlot overhead panel design, see pages 41 & 42) to view examples of a precast feed trough and an open bunk system.

Figure 45(a) A water trough design that delivers cool water to livestock. Source: Joven Chua, Elisa Farms, Mindanao.
The design in Figure 45(b) has a float operated valve at the bottom of the trough rather than the surface. This reduces the incidence of cattle and sheep water troughs overflowing and flooding feed pens.

The water level of this livestock water trough is maintained with the use of an inverted float valve. As the valve is positioned at the bottom of the trough, it is less likely to be damaged by livestock. Overflowing water troughs compromise livestock welfare and increase operation costs.

Figure 45(b) A water trough design - float valve inverted.

Image 5 A precast concrete feed trough with rounded corners to assist with cleaning.
Note, there is a raised step (150mm high x 350mm wide) at the front of the trough. The purpose of the step is to reduce the amount of faeces and urine that ends up in the trough. Faeces in the trough can contaminate the water and feed thereby increasing the incidence of salmonellosis.

Image 6 A good example of a water trough for a large feedlot pen showing a concrete apron surrounding the trough. Source: Mr Peter Cause of www.causecontracting.com.au.
Figure 47 The precast bunk trough is more suited to low rainfall areas and gives good protection against high winds (dimensions for this equipment are seen in Feedlot Panel 1). The open bunk has the advantages of lower fabrication cost per metre.

Figure 48 demonstrates the placement of troughs under rails for improved utilisation of space. This Figure also shows the step up to the trough to reduce the amount of faeces and urine that ends up in the trough (if the rear hoofs of the cattle touch the step-up, they will usually stop).
Image 7 A practical example of a sheep feedlot in MENA.

Image 8 A water trough in a sheep pen.
20 Simultaneously processing ESCAS and non-ESCAS cattle

Most successful ESCAS abattoirs hold minimal numbers of sheep or cattle at the abattoir or slaughterhouse in lairage pens. It is unlikely that many abattoirs would hold stock over into the next day. Most abattoirs can receive another truckload of livestock in a matter of hours, as the feedlots are generally nearby.

In some abattoirs, a separate unloading ramp, lairage pens, single file raceways and restraint box will be installed to handle non-ESCAS or local cattle.

Cattle and sheep can be processed in abattoir facilities that are processing ESCAS and non-ESCAS livestock simultaneously, provided the livestock can be kept separate until post slaughter. This can be achieved in most circumstances by modifications that include separate lairage, handling and slaughter facilities and cattle remain physically separated with the use of a wall or high panels at least 2 metres in height. Details and notes in the design show that there are no gates which join the ESCAS and non-ESCAS cattle. The design allows facilities to comply with ESCAS standards while minimising the cost of the conversion.

The same lighting system, pen water delivery, pen drainage, effluent treatment, and cleaning facilities can be utilised; Figure 49 (see next page). The design in Figure 49 shows how ESCAS and non-ESCAS cattle might be processed simultaneously and separately.

The design in Figure 49 uses a green line to show the path for ESCAS cattle and a red line to show the path for non-ESCAS cattle. At no point are ESCAS and non-ESCAS cattle allowed to mix.
Figure 49 Model of abattoir slaughter facilities allowing ESCAS and non-ESCAS cattle to be processed simultaneously. Source: Beere Engineering.
The design modelled in Figure 50 shows separate facilities to handle and process cattle and sheep at the same abattoir/slaughterhouse.

Figure 50 Model of a slaughter house (illustrating the security in more detail) allowing ESCAS and non-ESCAS cattle to be processed simultaneously. Source: Beere Engineering.

Figure 51 Models a design to allow imported sheep and cattle to be slaughtered simultaneously. Source: Raed Hijazi, Engineer.
Figure 52 is a simple design showing a lane allowing cattle to stand alongside each other, a small forcing pen and a short race, all plated on the inside, leading to the restraint box. This design is also suitable for North African cattle. All cattle respond to plated panels and curves, which encourage cattle to follow each other.

Figure 52. A model of a simple design of facilities leading up to restraint box. Source: Raed Hijazi, Engineer.
Figure 53 provides an overhead view of the same, simple design shown in Figure 52 (see previous page).
Figure 54 shows plans for a simple abattoir where ESCAS and non-ESCAS cattle and buffalo can be handled and slaughtered separately and simultaneously. This design demonstrates how an existing abattoir can be upgraded to comply with ESCAS standards.

Figure 54 Plan of simple abattoir where ESCAS and non-ESCAS cattle and buffalo can be processed separately and simultaneously. Source: Geoffrey Beere.
21 Cattle transport designs

A simple rule when designing or fabricating cattle transport is that the livestock truck or the trailer must have sufficient height in the pens for the cattle to stand without any part of their back touching the ceiling or bows (supports). Image 9 is an example of where poor design in cattle transport can cause problems.

Image 9 An example of the results of poor transport design. Source: Geoffrey Beere.

An example of a rub mark caused when a large animal was loaded on the lower deck of a livestock truck that did not have sufficient height between the first and second deck.

The carcase shown in Image 10 will be severely downgraded due to the bruising of the high value rump and loins. The animal did not have enough height between the lower and top decks of the transport.

Image 10 Severe bruising as a result of insufficient space between bottom and top decks of transport. Source: Geoffrey Beere.
Figure 55 is an example of a well-designed mode of cattle transport, which can be configured to work in importing countries and cities that have height and length restrictions. Points to note include: a crate which is equipped with a side loading option, a smooth interior, and a rear sliding gate.
22 Cattle pen density guides for transport, feedlot and lairage

It is important to have cattle and buffalo transported by truck, in the feedlot and in lairage, at the correct stocking density to maintain the health and welfare of the animals.

22.1 Transport by truck

If cattle or buffalo are too loosely loaded on trucks, the cost of transporting these animals will be comparatively high. However if the cattle or buffalo are too tightly loaded and an animal goes down, this animal may be injured by the other standing animals. Using the recommended stocking densities allows animals to support each other during transport and if an animal goes down it will not be injured. The stocking density for cattle of various weights is well documented and this manual has used these densities shown in the following Table 1 and Figure 56 (see next page).

It is most important that the truck is driven to the road conditions, especially in the first part of the journey (first 5-30 km). This will allow the cattle and buffalo to find their balance for the rest of the journey, so they do not slip over in the crate.

<table>
<thead>
<tr>
<th>Mean liveweight (kg)</th>
<th>Floor area (m²/head)</th>
<th>Head/pen length (12.5 m x 2.4 m deck)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>0.77</td>
<td>38</td>
</tr>
<tr>
<td>300</td>
<td>0.86</td>
<td>34</td>
</tr>
<tr>
<td>350</td>
<td>0.98</td>
<td>30</td>
</tr>
<tr>
<td>400</td>
<td>1.05</td>
<td>28</td>
</tr>
<tr>
<td>450</td>
<td>1.13</td>
<td>26</td>
</tr>
<tr>
<td>500</td>
<td>1.23</td>
<td>24</td>
</tr>
<tr>
<td>550</td>
<td>1.34</td>
<td>22</td>
</tr>
<tr>
<td>600</td>
<td>1.47</td>
<td>20</td>
</tr>
<tr>
<td>650</td>
<td>1.63</td>
<td>18</td>
</tr>
</tbody>
</table>

**Table 1 Trucking density for cattle and buffalo.**
Source: Australian Standard for the Export of Livestock (version 2.3).

Note. Calculations of the above buffalo numbers have been based on animals with horns that are no longer than the spread of the ears and are blunt.
Figure 56 Plan of cattle truck trailer/crate showing recommended loading densities. Source: Australian Animal Welfare Standards - Land Transport. Version 2.2. Diagram: Beere Engineering.
22.2 Feedlot

Figure 57 (see next page) is a model of a feedlot showing recommended stocking densities for the following types of pens:

- Pens with a dry compacted dirt floor
- Pens with a non-slip concrete floor surface, and
- Pens with a non-slip concrete floor and a roof.

The reason that a relatively higher stocking density is recommended for non-slip concrete flooring is that cattle will not bog and their welfare is not compromised by rainy or snowy weather. The moisture from rain or snow will largely run off the concrete surface.

Similarly the reason for a higher recommended stocking density, if the pen has a concrete floor and is covered with a roof, is that cattle will remain cooler under a roof, which will keep the overall pen temperature cooler.

There should be no partially concreted floor surfaces within a pen, as this can lead to a dry area and a boggy area and most of the cattle will try to congregate on the dry area effectively increasing the actual pen density in the area that the cattle regularly congregate.

22.3 Lairage

To meet ESCAS, livestock in lairage pens must meet the following standards:

- Animals must be protected from exposure to adverse weather conditions or alternative arrangements must be made to alleviate heat/cold stress
- Sufficient space is provided to allow animals to stand-up, lie down or turn around, and
- Flooring does not cause injury and minimises the occurrence of livestock slipping or falling.

Most international standards regulating lairage stipulate that there should be sufficient non-slip concreted floor area and roofed area to house one day’s slaughter capacity.

23 Sheep and goats

As for cattle, the same fundamentals apply when planning and designing facilities to handle and process sheep and goats. Refer to Section 7 Cattle and buffalo planning.

24 Building yards for sheep and goats

This manual has adapted the traditional, rectangular sheep yard to suit most feedlot and lairage situations. This traditional design can be adapted to other environments with the addition of:

- Paved floors, roofing and suitable drainage
- Loading and unloading ramps, and
- Large receiving pens and areas to draft, manage and/or medicate.

The design in Figure 59 (see page 80) is from the New South Wales (NSW) Department of Primary Industries. This design and others can be downloaded from the technical bulletin ‘Prime fact 924 (PDF)’. All the facilities in the NSW rectangular sheep yard can be built using the design PDFs in this manual.
Pen Density Table

Area 1C: Stock 500 to 600kgs.
Density, 4.8 sq metres per animal.
Contains 25 head.

Area 2C: Stock 500 to 600kgs.
Density, 4 sq metres per animal.
Contains 30 head.

Area 3C: Stock 500 to 600kgs.
Density, 3.5 sq metres per animal.
Contains 34 head.

Feedlot Stocking Density

<table>
<thead>
<tr>
<th>Weight Range</th>
<th>Housing Density</th>
<th>Number of Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 - 400 kgs</td>
<td>4 sq metres per animal</td>
<td>30 head</td>
</tr>
<tr>
<td>400 - 500 kgs</td>
<td>4.5 sq metres per animal</td>
<td>27 head</td>
</tr>
<tr>
<td>500 - 600 kgs</td>
<td>4.8 sq metres per animal</td>
<td>25 head</td>
</tr>
</tbody>
</table>

Note: All sample areas are 12 metres x 10 metres or 120 sq. metres. This area is nominal and for example purposes only.

Density data source AMIC.
Figure 58 Model of recommended lairage pen stocking densities. Source: Australian Meat Industry Corporation (AMIC). Design: Beere Engineering.

Lairage Pens Showing Density Plan

Pen Density Table

<table>
<thead>
<tr>
<th>Pen</th>
<th>Area (sq metres)</th>
<th>Stock Range</th>
<th>Density (sq metres per animal)</th>
<th>Number of Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>42</td>
<td>300 to 400kgs</td>
<td>1.4</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>42</td>
<td>400 to 500kgs</td>
<td>1.6</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>42</td>
<td>500 to 600kgs</td>
<td>1.8</td>
<td>22</td>
</tr>
</tbody>
</table>

Density data source AMIC.
Figure 59 Plan of a traditional, rectangular sheep yard. Source: NSW Department of Primary Industries (PrimeFact 924).
Figure 60 shows a more detailed plan of a traditional rectangular sheep yard.

Figure 60 Plan of traditional, rectangular sheep yard. Source: Beere Engineering.
Figure 61 shows a model of the same, traditional, rectangular sheep yard.

- 2m water trough accessible from 2 pens
- Panels with 5 rails so stock can see thru.
- Panels with 2mm sheetmetal panels
- 2 level transfer ramp
- Std. 5 wire fence

Traditional Rectangular Sheep Yard
Scale: NTS

Dimensions: A3

Source: Beere Engineering
25 Sheep and goat yard panels

Yard panel designs for sheep and goat yards are shown in Figure 62 (see next page). These yard panels are suitable for use in feedlots and in abattoir lairage pens. The materials and the design are most suitable, as galvanised plate and galvanised water pipe are readily available in livestock importing countries. These materials are the most cost effective and there are tradesmen available to maintain and repair these materials.

26 Sheep and goat drafting systems

There are numerous sheep and goat yard designs available from the websites of Australia’s state departments of agriculture.

The majority of the sheep and goat yard designs found at these sites can be fabricated from materials and plans found in this manual. Figure 63 (see page 85) shows the plans for sheep and goat yard gates.

A suggested system for the three-way drafting of sheep and goats is illustrated in Figure 64 (see page 86). For the smooth flow of livestock, care needs to be taken in correctly positioning the panels and gates.

It is important that materials used in the yard do not cause livestock to baulk. As an example, Image 11 shows sheep refusing to move forward as they can see their reflection in the galvanised sheeting used in the curved race.

It is recommended that all new 2mm galvanised plate fixed to panels and gates for sheep, cattle and goats is completely spray painted with a grey acrylic undercoat (no sheen). After time, when the acrylic paint wears off, the galvanised sheeting will lose its reflective properties. See Image 12.

Image 11 Sheep baulking at their reflection in galvanised sheeting on yard panels. Source: Geoffrey Beere.

Image 12 Sheep yard panels painted with grey, acrylic paint to stop reflection. Source: Geoffrey Beere.
Figure 62 Plans showing sheep and goat yard panels. Source: Beere Engineering.

Note: All panels can be manufactured in the lengths shown or in any variation in between.
Figure 63: Plans for sheep and goat yard gates. Source: Beere Engineering.

All Dimensions in mm.

1. **1.5 metre Gate with hinge**
   - Scale 1:10
   - 34OD pipe swaged oval before welding
   - 42OD x 3 pipe 100 long for hinges
   - 2mm galv. sheet welded to outside of pipe notched out for hinges & water drains at bottom

2. **2 metre Gate & Post**
   - Scale 1:10
   - 34OD pipe swaged oval before welding
   - 34OD x 3 pipe
   - 80 chain welded on gate 400 down from top

3. **0.4 metre Gate & Post**
   - Scale 1:10
   - 34OD x 3 pipe
   - 42OD x 3 pipe 100 long for hinges
   - 34OD x 3 pipe
   - 60OD x 3 pipe with 5 thick plates for hinges
   - 27OD x 2.6 pipe 850 long for hinge pin

4. **Ground level**
   - 2007
   - 1900
   - 1450

5. **Beere Gate hinge plate.**
   - 2 off 5mm. Scale 1:2
   - Ø28
   - 60
   - 30

6. **Cross section showing gate & panel posts fixed in concrete.**

7. **Sheep Yard Gates**
   - All Dimensions
   - Printed
   - Drawn by D Beere
   - Drafter 21/09/14
   - As Shown
Figure 64 Model and plan of three-way sheep and goat drafting yards. Source: David Kerr.

All Dimensions in meters

Drawn by Drawn
Scale A3

David Kerr Portable Drafting Race
Scale 1:60

2 x .8m drafting gates

3.5m

0.45m

2.0m

2.5m forcing gate

2 x 1.5m gates

5.7m

3.0m

7.3m

0.3m

3.0m

7.3m

2.0m

1.5m

2.5m

5.0m

3.5m
27  Unloading and loading ramps at feedlots and abattoirs

A recommended design for an unloading ramp for sheep and goats is shown in Figure 65. This model shows the double-deck design and the portability of the ramp.

Figure 65 Model of traditional sheep yard showing double-deck unloading/loading ramp. Source: Beere Engineering.
28 Port infrastructure and equipment

A design for an unloading ramp suitable for sheep and goats is modelled in Figure 66. The same ramp design would also be suitable for loading or unloading sheep or goats at a feedlot or slaughterhouse lairage. The inclusion of a drop down, lift up floor is simple and effective and is an improvement over using traditional ‘block and tackle’ to adjust the height of the ramp.

Figure 66 Model of unloading/loading ramp suitable for sheep and goats.
Source: John Edwards. Drafted by Beere Engineering.
Figure 67 shows a plan of the same ramp. The floor of the ramp is made of timber to take advantage of a reduction in noise, as noisy floors can confuse sheep. The wooden cleats provide improved non-slip flooring.

Source: John Edwards. Drafted by Beere Engineering.
29 Abattoir and feedlot raceways and laneways

The design modelled in Figure 68 (see next page) has two separate raceways starting at the circular forcing pen. Two of the centre panels in the twin race are fabricated using galvanised pipe and not galvanised sheeting. The ability of sheep in one raceway to see sheep in the adjacent raceway encourages the sheep to move forward. This design is capable of supplying a high throughput V restrainer for slaughter sheep or goats. The design can also be downsized to a single race to supply a ramp and slaughter table. There are several working models of this circular forcing pen in the market place and they have produced positive welfare improvements.

Figure 69 (see pg 92) shows a model of a sheep ramp and slaughter table, which is popular in the Middle East where the sheep are manually restrained by trained slaughter men. The design is favoured as it has the option of being replaced by a V restrainer including a V restrainer conveyor and is relocatable by undoing floor bolts. The ramp design is approved by ESCAS and is non-slip, has no sharp protrusions with a satisfactory slope (less than 20%).

30 Feedlot facilities

30.1 Shade

Refer to section 10.1 for information on shade.

31 Design suggestions for Eid al-Adha

Eid al-Adha Temporary Slaughterhouse design. Courtesy - David Kerr.
Figure 68 Model of a circular forcing pen for sheep and goats. Source: Beere Engineering.

- Both gates able to pivot 360° on 8900 centre post.
- Fluorescent lights suspended from ceiling approx 3m above centre of race.

Part of centre race fence fabricated from rails for inter race vision.

2.4m swing pipe rail gate with Beere hinge post.

Hatch pattern grooves formed into concrete surface before setting.

Fluorescent lights suspended from ceiling approx 3m above centre of race.

2.4m swing pipe rail gate with Beere hinge post.

Both gates able to pivot 360° on 8900 centre post.

Plan for Sheep & Goats Forcing Pen with Ramp & Table, Scale 1:75

2400 4500 1000 2000 2790 4400 4400 500 C/L 500 C/L 2400

Part of centre race fence fabricated from rails for inter race vision.

Hatch pattern grooves formed into concrete surface before setting.

Fluorescent lights suspended from ceiling approx 3m above centre of race.

2.4m swing pipe rail gate with Beere hinge post.

Both gates able to pivot 360° on 8900 centre post.

Plan for Sheep & Goats Forcing Pen with Ramp & Table, Scale 1:75

2400 4500 1000 2000 2790 4400 4400 500 C/L 500 C/L 2400

Part of centre race fence fabricated from rails for inter race vision.

Hatch pattern grooves formed into concrete surface before setting.

Fluorescent lights suspended from ceiling approx 3m above centre of race.
Figure 69 Model of sheep slaughter table and ramp. Source: Beere Engineering.

All Dimensions in mm.

Sheep Slaughter Table & Ramp
Scale 1:50

Blood drain

All material to be galvanised

PVC curtain hanging on 20NB pipe with galv chain in bottom pocket
100mm deep concrete poured into 2mm sheetmetal tray

3mm Sheetmetal

25NB pipe bolted across race as Hock restraint

3mm Sheetmetal

Std. sheep yard panels set in concrete, with 2mm sheetmetal

Sheep Slaughter Table & Ramp
Scale 1:50

Std. 400mm gate with 2mm sheetmetal panel

100NB pipe bolted across race as Hock restraint

400

100UB

480

700

1525

223

Sheep Slaughter Table & Ramp
Scale 1:50

480

700

1525

223

Sheep Slaughter Table & Ramp
Scale 1:50

100UB

80NB pipe

All material to be galvanised
32 Entering the restraining box

It is common practice in Middle Eastern countries importing Australian sheep and goats for these animals to be moved to the point of slaughter using either a motorised V restrainer or the animal walks up a ramp to the top of a table, where the animal is restrained or stunned prior to slaughter. The model in Figure 69 (see previous page) is an example of an existing sheep ramp and table that have been replaced with a V restrainer conveyer. This is seen as a logical upgrade.

Figure 70 Upgrading from a ramp to a V restrainer. Source: V Restrainer file supplied by FAE (Food Equipment Australia PTY LTD www.fea.net.au). Model prepared by Beere Engineering.
33 Restraint applications

33.1 Restraint at point of slaughter (approved by ESCAS)

Providing low stress restraint for animals prior to slaughter is an important objective of the livestock export industry. In 2014, the LEP conducted an extensive literature review to investigate and catalogue the different sheep restraint methods currently used in Australia and overseas. The aim was to identify possible approaches that exporters could consider using in their livestock export supply chains.

The literature review identified four broad categories of restraint in use. These were manual restraint (used in small processing facilities); knocking box single animal units; V-conveyor restraints (used in high throughput facilities); and side clamp restraints. Side clamp restraints were identified as the most commonly used devices. Based on the literature review, the researchers considered the potential application of restraint and they developed a new prototype for a sheep restraint device that could be used for slaughter purposes. A prototype has been developed and ESCAS approved. A restraint design must comply with both ESCAS and OIE guidelines for humane slaughter. The design must also respect the existing cultural and traditional slaughter values in the country of operation.

33.2 Prototype trampoline restraint (not approved by ESCAS)

Figure 72 (see next page) is a concept design only that will mount or fit to most of the existing abattoir infrastructure found in importing countries. This prototype restraint design includes the following features:

- The ramp incorporates a concrete floor [10cm thick] which is non-slip and with reduced hoof noise which sheep will ascend more readily
- The pipe frame of the restraint is fitted on each side with a trampoline mat and springs
- The trampoline mats are very durable and long lasting, providing uniform restraint for livestock weighing from 25 to 80 kg
- After the sheep or goat is slaughtered in the restraint, and in the absence of a corneal reflex, the animal can be moved to the adjoining table to await further processing
- As the neck of the sheep or goat protrudes from the front of the tube down pipes, there is little danger of slaughtermen cutting the mat
- The sheep displayed in the restraint is 65cm high at the withers and the height of the sheep restraint mat is 85cm; this should allow for all imported sheep and goats to be restrained, and
- The inclusion of a hock restraint where the restraint is a pipe mounted at 90° to the panelled race. If a sheep or goat backs up in the race, then one or both of its hocks will touch the pipe. The sheep or goat is deceived into thinking that it has reversed into a wall and subsequently will stand still.
Figure 72 Model of a prototype restraint frame for sheep and goats. Source: Beere Engineering.

Figure 73 Prototype sheep restrainer fabrication files. Source: Beere Engineering.

Figure 74 below shows a model view of a 60kg sheep in the restraint at 45°.

Figure 74 Model view of closed restraint frame at 45°, with 60kg sheep in the frame showing the positioning of a bleed table or roller conveyer. Source: Beere Engineering.
Figure 75 shows an empty restraint frame with hock restraint for ramp. The hock restraint discourages sheep from backing down the ramp.
34 Lairage and race designs for simultaneously processing ESCAS and non-ESCAS sheep and goats

Figure 77 (see next page) illustrates an actual upgrade of a municipal sheep and goat slaughterhouse in the Middle East. The ESCAS line is compact and relatively simple. Sheep are transported to the abattoir and are unloaded, moved and slaughtered through a separate section of the abattoir. The text in the design highlights the ramps for the local cattle, sheep and goats and the ESCAS design. ESCAS stock ascend a ramp to be slaughtered while the local sheep and goats are slaughtered over the drain. Figure 76 shows a model of the addition of an ESCAS raceway, ramp and slaughter table to an existing slaughterhouse/abattoir.

The infrastructure in Image 13 shows well designed laneways, V forcing pens and ramps leading to the slaughter table.
Figure 77 Plans of upgrade to an existing abattoir so as to be able to process ESCAS sheep and goats. Source: Geoffrey Beere.
35  Sheep and goat vehicle designs

Image 14 An example of a wooden crate used for live air transport of sheep and goats.
### 36 Pen density guides for transport, feedlot and lairage

As for cattle and buffalo, it is important to have sheep and goats transported by truck, in the feedlot and in lairage, at the correct stocking density to maintain the health and welfare of the animals.

#### 36.1 Transport

The stocking density for transporting sheep and goats of various weights is well documented and this manual has used these densities shown in the following Table 2.

If sheep and goats are too loosely loaded on trucks, the cost of transporting these animals will be comparatively high. However if the sheep and goats are too tightly loaded and an animal goes down, this animal may be injured by the other standing animals. Using the recommended stocking densities will allow animals to support each other during transport and if an animal(s) goes down, the animal(s) will not be injured.

It is most important that the truck is driven to the road conditions, especially in the first part of the journey (first 5-30 km). This will allow the sheep and goats to find their balance for the rest of the journey, so they do not slip over in the crate.

<table>
<thead>
<tr>
<th>Mean liveweight (kg)</th>
<th>Floor area (m²/head)</th>
<th>Head/pen length (2.4 m wide tray)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3.0 m</td>
</tr>
<tr>
<td>20</td>
<td>0.17</td>
<td>42</td>
</tr>
<tr>
<td>30</td>
<td>0.19</td>
<td>38</td>
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<tr>
<td>40</td>
<td>0.22</td>
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</tr>
<tr>
<td>50</td>
<td>0.25</td>
<td>29</td>
</tr>
<tr>
<td>60</td>
<td>0.29</td>
<td>25</td>
</tr>
</tbody>
</table>

(1) Calculations of the above sheep numbers have been based on animals in half-wool.

(2) When transporting full-wool sheep, the number should be reduced accordingly; when transporting newly shorn sheep, it should be increased accordingly.

<table>
<thead>
<tr>
<th>Mean liveweight (kg)</th>
<th>Floor area (m²/head)</th>
<th>Head/pen length (2.4 m wide tray)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3.0 m</td>
</tr>
<tr>
<td>20</td>
<td>0.117</td>
<td>62</td>
</tr>
<tr>
<td>30</td>
<td>0.165</td>
<td>44</td>
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<td>0.213</td>
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<tr>
<td>50</td>
<td>0.261</td>
<td>28</td>
</tr>
<tr>
<td>60</td>
<td>0.309</td>
<td>23</td>
</tr>
</tbody>
</table>

(1) Large-horned animals require additional space depending on the size of horns.

Table 2 Trucking density standards for the land transport of sheep and goats.

Source: Australian Standards for Export of Livestock (Version 2.3.).
36.2 Lairage

Figure 78 shows recommended stocking densities in abattoir lairage. All livestock should have the ability to stand up, sit down, lie down and/or turn around. In addition, lairage areas must have non-slip concrete floors and a covered area large enough to house enough animals for one day’s slaughter.

Figure 78 Model of sheep stocking density in lairage. Source: Beere Engineering. (The density information from final report B.LIV.0127 prepared by Dr D. Savage, www.mla.com.au).
Figure 79 Model of feedlot showing recommended stocking densities for sheep and goats. Source: Mawashi Feedlot Recommendations 20/07/2008, Peter Dundon.

Pen Density Table

Area 1A: Stock up to 35kgs.
- Density: 1.5 sq metres per animal.
- Contains 33 head.

Area 2A: Stock up to 35kgs.
- Density: 1.25 sq metres per animal.
- Contains 40 head.

Area 3A: Stock up to 35kgs.
- Density: 1.0 sq metres per animal.
- Contains 50 head.

Note: All sample areas are 10 metres x 5 metres or 50 square metres. This area is nominal and for example purposes only.

Density data source AMIC.

Pen Density Table

Area 1B: Stock 35 to 45kgs.
- Density: 2.0 sq metres per animal.
- Contains 25 head.

Area 2B: Stock 35 to 45kgs.
- Density: 1.75 sq metres per animal.
- Contains 29 head.

Area 3B: Stock 35 to 45kgs.
- Density: 1.5 sq metres per animal.
- Contains 33 head.

Pen Density Table

Area 1C: Stock 45kgs plus.
- Density: 2.5 sq metres per animal.
- Contains 20 head.

Area 2C: Stock 45kgs plus.
- Density: 2.25 sq metres per animal.
- Contains 22 head.

Area 3C: Stock 45kgs plus.
- Density: 2.0 sq metres per animal.
- Contains 25 head.

Note: Stock are shown spaced out and oriented evenly and not naturally to better show the different stocking densities.
36.3 Feedlots

Figure 79 (see previous page) is a model of a feedlot showing recommended stocking densities for the following types of pens:

- Pens with a dry compacted dirt floor
- Pens with a non-slip concrete floor surface, and
- Pens with a non-slip concrete floor and a roof.

The reason for a higher recommended stocking density if the pen has a concrete floor and is covered with a roof is that sheep and goats will remain cooler under a roof, which will keep the overall pen temperature cooler. There should be no partially concreted floor surfaces within a pen as this can lead to a dry area and a boggy area, and most of the sheep and goats will try to congregate on the dry area, increasing the density.

Table 3 shows the recommended pen density for different classes of sheep.

<table>
<thead>
<tr>
<th>Class</th>
<th>Space allowance (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambs</td>
<td>0.5 – 1.0</td>
</tr>
<tr>
<td>Dry adults</td>
<td>1.5 – 4.0</td>
</tr>
<tr>
<td>Ewes in late pregnancy</td>
<td>4.0 – 8.0</td>
</tr>
<tr>
<td>Ewes with lambs at foot</td>
<td>8.0 – 13.0</td>
</tr>
</tbody>
</table>

*Rates should be less intensive in summer – ie. at the higher end of the space figures*

Table 3 Pen densities for different classes of sheep. Source: Peter Dundon.

36.4 Goat information

Please click on the following link for information on goat handling, behaviour and infrastructure.

Link: Goat Information
Infrastructure Doc,
Fact Sheet - Understanding Goat
Behaviour & Handling,
Fact Sheet - Goat Infrastructure
37 General equipment and application for cattle, sheep and goats

This section deals with a number of individual issues that relate to improving the welfare and efficiency of handling and processing cattle, sheep and goats.

37.1 Stunning

Stunning practices should meet the minimum standards contained in ESCAS. A number of practical tips in the use of stunning include:

- Live weight of cattle is not a reliable, sole indicator when calculating the size of the power load required to stun the animal
- Stunners that are operated by a power load will need to be cleaned regularly. The use of CRC or WD-40 seems to be the most practical solvent to clean and maintain a stunner. See Image 15. The cordite contained in the power load is the main cause of corrosion, wear and loss of velocity
- A large green coconut can be used as a target when training stunner operators in Asia. Alternatively, the side wall of an old truck tyre will also suffice and neither should damage the stunner
- Never alter the air pressure recommended by the manufacturer to fire a pneumatic stunner
- Never hold the stunner off the head of the animal with the hope of reducing the indent into the cranium
- A skilled stunner operator will place the stunner on the target site as they activate the trigger and will never close their eyes at the time of the stun
- Effective training can be assisted by the trainer recording video footage of the trainee
- Power loads that power captive bolt stunners are required to be stored in air-conditioned storage. Exposure to humidity in storage will reduce the performance of the stun.

![Image 15 Cleaning and maintenance of stunners. The solvents WD-40 and CRC can be seen in the photos. Source: Geoffrey Beere.](image15.jpg)
37.2 Sheep trolley update

Sheep trolleys were developed as a means of delivering a sheep or a goat identified as an ‘emergency slaughter’ or ‘downer animal’ to the point of slaughter. See Figure 80 and Figure 81 (see next page). Emergency slaughter sheep or goats are unable to stand or walk unaided onto transport or be unloaded and walked through an abattoir to be killed. The sheep trolley is also able to deliver ‘emergency slaughter’ sheep and goats from livestock markets to the point of slaughter.

Figure 80 Plan of modified sheep trolley - perspective 1. Source: Beere Engineering.
Amal Services Pty. Ltd.
Darwin, NT. Australia

<table>
<thead>
<tr>
<th>Project</th>
<th>Modified Sheep Trolley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>Cradle &amp; Mounting Bkts.</td>
</tr>
<tr>
<td>Cutting &amp; Folding Dimensions</td>
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<td>DPB 22-10-2014</td>
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Note: All holes 9Ø unless otherwise shown.
All folds upwards on folding line and 90° unless otherwise shown.
8Ø to 10Ø round bar welded to outer edge of cradle, where possible, for protection.
All dimensions in millimetres.

Mounting Position
Front View.
Scale 1:10

Mounting Position
Side View.
Scale 1:10

Cradle Ass.
Perspective view

Note: Mounting position dimensions are approximate and may vary with different commercial trolleys.
37.3 Four-wheeled cart for sheep and goats

Where sheep and goats arrive at slaughterhouses in vehicles as individuals or a pair of animals, both the two and four-wheeled carts or trolleys are suitable for delivering them to the point of slaughter. See Image 16. The two-wheeled trolley is safe to transport suspect/downer sheep and goats, as they are cradled in the trolley with no weight bearing on their legs. Both models should have pneumatic tyres fitted to improve the ride and reduce the noise level which can frighten sheep and goats.

Image 16 Two-wheeled and four-wheeled trolleys in operation. Source: Geoffrey Beere.

37.4 Sheep and cattle talker

The sheep and cattle talker, Image 17 (see next page) introduced in the early 2000s has proved to be a very useful tool and also acted as a catalyst for the upgrading of knowledge on methods to improve the welfare of livestock. Refer to Work Instructions: use of livestock handling equipment, available by contacting livecorp@livecorp.com.au.
37.5 A practical sheep lure

Historically sheep in some countries are encouraged to move forward by a single animal in the lead which is held by a stock person and acts as a lure for the rest of the sheep to follow. See Image 18. The adaptation of the trolley as a lure has been trialled with some success. It appears that a dry pelt is as effective as a fresh pelt.
37.6 Shade cloth panel to move sheep around facilities

Arabic and fat tailed sheep are not like most imported sheep and are reluctant to lead or move forward; they will follow but not lead. With a stock person on each end of a shade cloth panel using wooden batons, sheep can be successfully moved in feedlots and in lairage. See Figure 82. This system simply reduces the area or space in the pen or yard by moving the shade cloth in the desired direction. It is important to not let the shade cloth flap or make any noise, as this will only confuse the sheep.

Figure 82 Model of shade cloth panel to help move sheep. Source: Geoffrey Beere.

37.7 Portable panels - cattle, sheep and goats

Portable fences or yard panels for cattle, sheep and goats can be useful in feedlots and in abattoirs where permanent fencing or pens do not exist. Figure 83 (see next page) shows plans for portable panels which are suitable for cattle, sheep and goats. The use of high tensile steel rather than the much heavier mild steel makes portable panels much easier to manhandle and so modifications to a feedlot or lairage can be made without as much effort. Cattle and sheep panels are usually fixed into a sleeve and fixed with a wire tie.

37.8 Cattle carcase cradle

To keep costs down in importing countries, a wheeled dressing cradle will contribute to efficient meat processing in many abattoirs/slaughter houses (abattoirs will usually dress out on the rail). The restraint or stunning box should be on a raised plinth so that the slaughtered animal can be transferred or rolled directly to the cradle without the need for an electric hoist. This has considerable cost savings, as hoists require three-phase power. Figure 84 (see page 111) shows a smaller cradle used for cattle of live weights to 500kg and the larger version designed for cattle up to 800kg live weight. If the slaughter floor surface is not smooth, it is recommended to increase the diameter of the nylon wheels.
Portable Stock Fence Panels Dimensions in mm

2m Portable Sheep Fence Panel with rails. Scale 1:20

2m Portable Cattle Fence Panel with rails. Scale 1:20

Steel wire twist for joining panels

42OD x 3 pipe x 100 long for joining panels welded to one leg

Ground level

All construction with 34 x 3 CHS

All joins 10 flat bkts with 12 Ø pins

Perspective View of Sheep Fence Panels. Scale NTS

Perspective View of Cattle Fence Panels. Scale NTS

Figure 83 Plans and models of portable panels for cattle, sheep and goats. Source: Beere Engineering.
Figure 84 Plans of cattle dressing cradles. Source: Beere Engineering.

All Dimensions in mm.

Cradle for medium cattle
Scale 1:10

Cradle for large cattle
Scale 1:10
37.9 Electric goads

In the majority of cases where a goad or jigger is used to move livestock forward, there is usually an underlying problem which can be fixed. The solution may be:

- To redirect lighting - livestock move forward to lighter areas
- Remove visual distractions, which is usually people. If people cannot be relocated, a shade cloth (90-95%) barrier is a good fix, and
- Remove noise distractions, which is usually machinery or equipment in the wrong place.

Most Australian cattle do not require a painful jab with an electric jigger. They are trained from a young age to move forward through laneways and raceways. Most Australian cattle are eager to move forward provided they are not stressed by stock persons or the environment.

The best approach is to show cattle an opening, which could be the entrance to a race or ramp, a truck or a restraining box.

Meat science studies show that cattle subjected to acute pre-slaughter stress using electric goads produced meat which the consumer rated as tougher with inferior quality (Warner et al, 2007). Note: Electric gates are not to be used on sheep or goats (Refer Appendix 3).

37.10 Pen cleaning equipment

A practical example of equipment to clean cattle, sheep and goat pens is shown in Image 19. The blade on the front of the walk-behind tractor is modified from a split vehicle tyre.
37.11 Adjusting the width of a cattle race

*Image 20* shows images of a practical method to reduce the width of a conventional, straight cattle race. A standard 70cm wide race can be narrowed to 50cm at a height of 80-90cm from the ground. This modification will allow the race to be used effectively for much smaller cattle, such as weaners. In the full width race, weaners or small cattle would try and turn around or squeeze past animals in front.

Image 20 How to adjust the width of a cattle race. Source: Jim Lindsay, Landsborough Station, Queensland.

37.12 A slaughterman’s scabbard

Slaughtermen without a knife scabbard at the point of slaughter will run the risk of injuring the livestock or themselves. For little cost, a section of 95mm PVC pipe can be heated and moulded to serve as a knife scabbard. See *Image 21*.

Image 21 A slaughterman’s knife scabbard. Source: DLD (Department Livestock Development), Bangkok, Thailand.
## 38 Acknowledgements

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- Mr. Willie Taylor, Yard Builder & Stockman, Acacia Creek, Northern Territory
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- Mr. Brendan Collins, Malang, Indonesia
- Dr Temple Grandin, http://grandin.com

## 39 Appendices

### Appendix 1 Table showing critical cold temperatures


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Wind-chill Factor

**Little Danger**  
**Increasing Danger**  
**Great Danger (Death in younger animals)**
### Appendix 2 Table showing critical hot temperatures and humidity

**Source:** Livestock Conservation Inc., Kansas City, Kansas.

| Relative Humidity Intervals (%) | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
|--------------------------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 75°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 76 | 75 | 75 | 75 | 75 |
| 76°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 76 |
| 77°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 76 |
| 78°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 78 |
| 79°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 78 |
| 80°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 79 |
| 81°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 81 |
| 82°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 82 |
| 83°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 83 |
| 84°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 84 |
| 85°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 85 |
| 86°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 86 |
| 87°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 87 |
| 88°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 88 |
| 89°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 89 |
| 90°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 90 |
| 91°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 91 |
| 92°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 92 |
| 93°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 93 |
| 94°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 94 |
| 95°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 95 |
| 96°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 99 |
| 97°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 98 |
| 98°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 99 |
| 99°                            | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 100 |
| 100°                           | 70 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 75 | 76 | 76 | 76 | 105 |

Temperatures above 100 are always “Danger” and if the relative humidity is above 25 percent, the situation is “Emergency”.

*Source Livestock Conservation, Inc. Kansas City, Kansas*
Acute stress induced by the preslaughter use of electric prodders causes tougher beef meat

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Abstract. Adrenergic activation and hormone release preslaughter is an inevitable outcome of the systems used to move cattle to slaughter. The aim of this experiment was to investigate the effects of acute preslaughter stress in beef cattle on postmortem muscle metabolism and the meat quality, including consumer-assessed eating quality. Eighty-four cattle were used on three separate days, with ‘ mobs’ of four cattle allocated to either a ‘control’ (no electric goads used preslaughter) or a ‘stress’ (six prods given with an electric goad over 5–10 min) treatment at 15 min preslaughter. Cattle undergoing the ‘stress’ treatment had higher plasma lactate at slaughter. The prerigor pH and temperature, ultimate pH and temperature at rigor of the longissimus thoracis muscle were similar between treatments (\(P > 0.05\) for all). The water-holding capacity of the longissimus lumborum was reduced by the ‘stress’ treatment, as indicated by higher levels of water lost during suspension (drip loss), storage (purge) for 21 days and cooking (cooking loss at 1 day postslaughter) (\(P < 0.05\) for all). ‘Stress’ cattle produced longissimus lumborum muscle with similar sarcomere lengths and Warner–Bratzler shear force at 2, 6 and 21 days, compared to ‘control’ cattle (\(P < 0.05\) for all). The longissimus lumborum muscle of cattle undergoing the ‘stress’ treatment was rated less tender, less juicy, with a less acceptable flavour, a lower ‘liking’ and a lower MQ4 score (\(P < 0.05\) for all). The ‘bloomed’ surface colour (CIE \(L^*, a^*, b^*\)) of the longissimus lumborum muscle at 2, 6 and 21 days postslaughter was similar between the ‘stress’ and ‘control’ treatments (\(P > 0.05\) for all). In conclusion, cattle subjected to acute preslaughter stress using electric goads produced meat which the consumer rated as tougher with inferior quality. The inferior quality induced by the acute stress treatment was associated with reduced water-holding capacity but was independent of muscle pH and temperature.

Introduction

Adrenergic activation and hormone release preslaughter is an inevitable outcome during the preslaughter handling of cattle. Cattle must arrive in a continuous stream at the stunning point (Gregory 1998) and most animals should walk calmly into a stunning pen or restrainer, preferably without the use of an electric goad (Grandin 1998). Although it is desirable to minimise the use of electric goads during the unloading and loading of trucks and preslaughter handling, inevitably they are still applied to varying degrees in many Australian beef abattoirs.

The negative effect of stress on beef quality has previously been attributed to the mobilisation of muscle glycogen during stress, the lack of acidification postmortem and the occurrence of ‘dark-cutting’ or high ultimate pH beef. Warriss (1990) states ‘the major influence of preslaughter handling on lean meat quality is through the potential effect on muscle glycogen stores’. Aside from the unacceptably dark colour of dark-cutting meat, it also has reduced eating quality (bland flavour, variable tenderness) in addition to reduced keeping quality (Tarrant 1989a). For these reasons, meat with an ultimate pH > 5.7 is excluded from the Meat Standards Australia (MSA) grading system (Ferguson et al. 1999).

Whilst the association between preslaughter stress and muscle glycogen depletion has been extensively studied in ruminants, the same cannot be said for the association between stress preslaughter and postmortem glycolytic rate. This is in contrast with the large body of recent research in pigs (e.g. Klont and Lambooy 1995; Warriss et al. 1995; Channon et al. 2000; Stoier et al. 2001). The general finding across these pig studies was that stress just before stunning resulted in lower initial muscle pH, higher initial muscle temperature and a faster rate of pH decline in the first hour after death, although similar rates were observed beyond that. There is a paucity of similar data in ruminants, but it is highly likely that acute stress preslaughter may alter the rate of postmortem pH fall and thus change the carcass response to electrical stimulation. Electrical stimulation is used to ensure that the optimum muscle pH–temperature window, as defined within the MSA grading system (Ferguson et al. 1999), is achieved. It is known that, within a consignment of cattle, the rate of pH fall in the longissimus can vary widely (O’Halloran et al. 1997). Consequently, this can affect the proportion of carcasses that achieve the optimum pH–temperature window. Furthermore, if electrical stimulation is applied to the carcass of an animal that has undergone acute stress preslaughter, the resulting rate of pH fall may be so rapid that the muscle proteins denature and produce pale, watery beef. Pale, watery meat has a reduced ability to tenderise during aging (pork; Channon et al. 2000) and...